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OF THE

MANCHESTER

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NOTE.

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The authors of the several papers contained in this volume are themselves accountable for all the statements and reasonings which they have offered. In these particulars the Society must not be considered as in any way responsible.

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Manchester Memoirs, Vol. li. (1906), *No.* 1.

I. A Preliminary Account of the Life-history of the Common House Fly (*Musca domestica* L.).

By C. GORDON HEWITT, B.Sc.,
Demonstrator of Zoology in the University of Manchester.

Received and Read October 2nd, 1906.

During the summer of this year I have been making some investigations on the life-history of the Common House Fly, *Musca domestica* L. for a monograph which I am preparing on that insect. As the life-history of *M. domestica* has not been studied previously in this country, so far as I am aware, a short preliminary account of the results obtained from this year's experiments may be of some interest

The life-history has previously been studied in America by Packard ('74) at Salem, Mass., and more recently by Howard ('02) at Washington. Their results differ slightly and are given at the end of the accompanying table. The female fly lays about one hundred and twenty eggs in the crevices of horse excrement, which must be fresh or the flies refuse to deposit their eggs. I experienced considerable difficulty in getting the flies to lay their eggs in confinement. When excrement is exposed before an open window large numbers of the eggs of other species of flies, which inhabit houses, are deposited, chiefly, I found, those of *Anthomyia radicum* L.

The experiments were begun early in August and continued to the end of September. During this time five lots of larvae were reared, each batch experiencing different conditions of temperature. By keeping the conditions as regards moisture and supply of food uniform, I was able to study the effects of the variability of

October 23rd, 1906.

the Manchester weather on the rate of development. I plotted out a curve of the daily mean temperatures (taken from six readings) and found that a rise in temperature produced an acceleration of the rate of development at any stage of the life-history, that is, shortened the time taken by that particular stage.

In the larval state there are two moults, that is, three stages can be recognised. In the first stage the larvae have only one pair of respiratory apertures, or stigmata, which are situated at the posterior end of the body on the last abdominal segment. In the second and third larval stages a pair of prothoracic or post-cephalic stigmata are found in addition to the posterior stigmata. The latter are slit-like in the second larval stage, two slits to each of the stigmata. In the third larval stage they are roughly semicircular with thickened chitinous rims and the flat sides opposite.

The following table gives a summary of my results; the results of Packard and Howard are given at the bottom for comparison.

Series.	Egg.	Larva.			Pupa.	Total Time.
		1st stage.	2nd stage.	3rd stage.		
1	24 hrs.	3 days	4 days	6 days	6 days	20 days
2	24 hrs.	2 days	4 days	4 days	9 days	20 days
3	36 hrs.	2½ days	2 days	6 days	12 days	24 days
4	24 hrs.	2 days	2 days	7 days	18 days	30 days
5	24 hrs.	2 days	2 days	8 days	17 days	30 days
Packard	24 hrs.	1 day	1 day	3 or 4 days	5–7 days	10–14 days
Howard	8 hrs.	1 day	1 day	3 days	5 days	10 days

Remarks.

The length of the larval stages of Series 1 was due to the low and variable temperatures experienced during that time. During the pupal state very hot weather supervened (September 1st) which caused the flies to emerge in the shortest time I have observed in the experiments.

During the same period of hot weather Series 3 were in the third larval stage which was prolonged by the larvae being allowed to remain in rather dry conditions. Series 4 and 5 were in their first and second larval stages during the few hot days, and both these stages were short. Immediately after the hot weather which we had for a few days at the beginning of September, there was a drop in the temperature and it has been comparatively low since, referring to the mean temperature of course.

This low temperature caused an excessive prolongation of the 3rd larval and pupal stages of Series 4 and 5.

It will be seen from the table that there is considerable difference in the time taken by different batches of larvae to develop. The shortest time is twenty days and the longest thirty.

If the shortest times of the different stages be taken, it is found that they are:

Time from deposition of egg to emergence of larva	24 hours.
First larval stage	two days.
Second larval stage	two days.
Third larval stage	four days.
Pupal state	six days.

The whole period from the deposition of the egg to the exclusion of the imago would last about fifteen days.

so that, given a spell of really hot weather we might have flies developing in a fortnight or even less, in England. Packard and Howard found that the time taken from the deposition of the egg to the emergence of the fly was about ten to fourteen days.

As this communication is only of a preliminary nature further details of the development, together with the results of further experiments, which it is my intention to make, will be incorporated in the account of the larva which will be published later.

LITERATURE.

'74. PACKARD, A. S. "On the Transformations of the Common House Fly, with notes on allied forms." *Proc. Boston Soc. Nat. Hist.*, vol. 16, p. 136—150, 1 pl.

:02. HOWARD, L. O. "House Flies" ("The Principal Household Insects of the United States," by L. O. Howard and C. L. Marlatt). *United States Department of Agriculture, Washington. Division of Entomology, Bull.*, no. 4, N.S. Revised ed., p. 43—47 and figs.; and *Circular*, no. 35, 2nd Series, p. 1—8 and figs., 1898.

DE GEE, R. first described the transformations of *M. domestica* in his "Mémoires pour servir à l'Histoire des Insectes." 8 vols. Stockholm, 1752-'78, but did not give the time taken by the various stages.

Manchester Memoirs, Vol. li. (1907), *No.* 2.

II. On some Points of Chemical Philosophy involved in the Discovery of Radium and the Properties of its Combinations.

By HENRY WILDE, D.Sc., D.C.L., F.R.S.

Received and Read November 27th, 1906.

The discovery of no elementary substance has created such profound and general interest as that of Radium. This is abundantly evident from various scientific publications and from magazine articles on "The Wonders of Radium," "The Revelations of Radium," "The Miracle of Radium," and other titles equally striking. Although the new element has not yet been isolated, the fact that it has a well defined spectrum, and that its chemical reactions agree closely with those of barium, leave no room for doubt of its existence, and that it is one of the alkaline-earth family of metals.

Radium, as I have already shown,[1] has a definite position, atomic weight, and specific gravity in my tables of atomic weights (1878, 1894, 1903), and is the next member higher to barium, as well as the highest of the series of alkaline-earth metals.

Operating with less than two grains of radium chloride, Mme. Curie deduced for the element an atomic weight of 225, and places it in the column of alkaline-earth metals, the member next above barium.

From spectroscopic observations, Runge and Precht,[2] while agreeing that radium belongs to the barium group,

[1] *Manchester Memoirs*, vol. 48, 1903–1904.

[2] *Journ. Chem. Soc.*, vol. 84, p. 346, 1903.
Phil. Mag., April, 1903, p. 476.

December 19th, 1906.

propose 258 as its atomic weight, as against 225 the value assigned to it by Mme. Curie.

Now, there is good reason to believe that neither of these numbers is the atomic weight of radium. An examination of the following table will show that, as a consequence of the law of multiple proportions by which the atomic weights of the series Hn and H2n are determined, there is a common difference of 23 between the atomic weights of the series Hn, commencing with Ka, to the final member Hg. In like manner there is a common difference of 24 in the strictly parallel series H2n.

Hn		H2n	
H = 1	Diff.	He = 2	Diff.
	− 6		− 6
0 . 0 . 7 Li = 7		0 . 0 . 8 = Gl = 8	
	− 16		− 16
1 × 23 . 0 = Na = 23		1 × 24 − 0 = Mg = 24	
	− 16		− 16
2 × 23 − 7 = Ka = 39		2 × 24 − 8 = Ca = 40	
	− 23		− 24
3 × 23 − 7 = Cu = 62		3 × 24 − 8 = Zn = 64	
	− 23		− 24
4 × 23 − 7 = Rb = 85		4 × 24 − 8 = Sr = 88	
	− 23		− 24
5 × 23 − 7 = Ag = 108		5 × 24 − 8 = Cd = 112	
	− 23		− 24
6 × 23 − 7 = Cs = 131		6 × 24 − 8 = Ba = 136	
	− 23		− 24
7 × 23 − 7 = — = 154		7 × 24 − 8 = — = 160	
	− 23		− 24
8 × 23 − 7 = — = 177		8 × 24 − 8 = Ra = 184	
	− 23		− 24
9 × 23 − 7 = Hg = 200		9 × 24 − 8 = Pb = 208	

I have already discussed the remarkable alternation of light and heavy metals in regular order observable in

each of these series, and have put forward suggestions as to its possible cause in my first paper on the "Origin of Elementary Substances," published in the *Proceedings* of the Society, 1878, and *Memoirs*, 1887.

In my later tables it will be seen that the alkaline-earth metals are of small specific gravity which increases with their atomic weight. Thus we have calcium, sp. g. 1·58; strontium, 2·54; barium, 3·75; radium, 4·8 approximate. Now, as the atomic weights of both series of elements increase by definite increments of 23 and 24 respectively, it follows by just analogy that if the series H2n were continued, the next member after lead would have an atomic weight of 232 (208+24) or seven units higher than Mme. Curie's determination for radium, with an approximate specific gravity of 7. Another increment of 24 would give 256, or two units less than the atomic weight assigned by Runge and Precht for radium. But this number would transfer the new element from the series of alkaline-earth metals to the alternate series of heavy metals containing lead and zinc. Moreover, in none of the series of elements is there any with atomic weights so high as 225 and 256 correlated with specific gravity so low as 5 or 7. The determinations of Mme. Curie, and Runge and Precht, therefore, afford no reason for changing the position of radium in my table of elements as the next higher member of the alkaline-earth metals to barium, with an atomic weight of 184, and a proximate specific gravity of 5.

I have shown in former papers that helium is the typical element of the series H2n, with an atomic weight of 2 (He = 2), a value now adopted by French chemists in the Table of atomic weights published in the *Annuaire du Bureau des Longitudes*. This value agrees with those of the other elementary gases (H, O, N, Cl), the atomic

weights of which are the same as their specific gravities at ordinary temperatures. The atomic weight of 2 is further confirmed by the remarkable parallel differences in the atomic weights (6 and 16) of the head members of the positive series Hn and H2n.

I have stated in my former paper that there is abundant reason for concluding that no elements exist of higher atomic weights than those shown in each series of the table; the series H2n containing radium, consequently, closes with lead.

From the fact that lead is always found in radio-active minerals, and for other reasons, Boltwood[1] and Rutherford[2] have each independently arrived at the conclusion that lead is the final or end product of the transformation of radium.

Dumas and other eminent chemists long ago classified lead as the homologue of the alkaline-earth metals, but the requirements of Mendeleeff's periodic system necessitate the placing of this element in his fourth group as the homologue of thorium, and the anomalous substitution of mercury (200) for lead in the series containing the alkaline-earth metals. (*v. Addendum.*)

It is a singular circumstance that, notwithstanding the wonderful powers attributed to radium, no chemist has yet seen or handled the element in its metallic state, in order that its general physical properties might be made the subject of investigation.

In my last paper read before the Society,[3] reference was made to the property which the sulphur combinations of the positive series H2n possess of becoming luminous

[1] *Phil. Mag.*, April, 1905.

[2] *Journ. Chem. Soc.*, November, 1905.

[3] *Manchester Memoirs*, 1903.

when exposed to the action of solar or electric light, and retaining their phosphorescence for more or less time after the source of light has been removed. Calcium, strontium, barium, and zinc sulphides possess this property in different degrees, while the radium combinations of the same series are permanently self-luminous.

Now it is admitted on all hands that elementary metallic calcium, strontium, barium, and zinc do not exhibit the property of phosphorescence of their sulphur compounds, and in this respect behave like ordinary metallic substances. By strict analogy metallic radium would, in like manner, be divested of all the extraordinary properties which have been attributed to it, and opened out so wide a field for ultra-scientific hypotheses.

In my first paper on elementary transformations I directed attention (1) to the strict parallelism existing between the electro-negative halogens, fluorine, chlorine, bromine, iodine, with the electro-positive alkaline metals, sodium, potassium, rubidium, caesium, and the common difference of 4 between the atomic weights of the parallel series, and (2) the like parallelism between the electro-negative elements, oxygen, sulphur, tellurium, selenium, with the electro-positive alkaline-earth metals, magnesium, calcium, strontium, barium, and the common difference of 8 between the atomic weights of these series.

The numerical, chemical, and physical properties of the four series of these elements clearly indicate them to be positive and negative analogues of each other and of hydrogen.

The intensely electro-negative character of the halogen and oxygen series induced me to affirm in my first paper that at an early period of their history the two series existed in a state of isolation from all the others. The subsequent chemical combinations of these eight

elements (with their beautiful gradation of properties) constitute the foundation, and much the greater part of the huge fabric of modern chemistry.

As the luminous properties commonly attributed to the alkaline-earth series of elements only become manifest when in combination with elements of the halogen and oxygen series, it may be maintained, with good reason, that the extraordinary properties attributed to radium really belong to the negative elements with which it enters into combination. It is no refutation of the view now advanced to say that the property of luminescence is not manifested in all combinations of the negative elements with the other elements. The phosphorescent and other relations to light, heat, electricity, and magnetism of the halogen and oxygen series are too numerous in inorganic, as well as in organic nature, to permit the denial to them of a selective affinity for the manifestation of properties now attributed almost exclusively to radium and its congeners of the series H_2n. It will be sufficient if I mention in this connexion (1) the luminescence and radio-active properties of phosphorus by its slow *oxidation*, and (2) the phosphorescence of decaying organic matter, and of many insects; the most notable of the latter being the *Pyrophorus noctilucus*, the luminous organs of which have been made the subject of experiment by S. P. Langley and F. W. Very[1].

Macaire[2], Matteucci[3], Langley, and others agree that the phosphorescence of insects is due to *oxidation*, and is attended by the formation of carbon dioxide; the light is increased in oxygen, and extinguished in hydrogen and

[1] *Amer. Journ. Science*, vol. 40, p. 97, 1890.
Smithsonian Misc. Coll., vol. 41 (1258), p. 19, 1901.
[2] *Bib. Univ. de Geneve*, 1821.
[3] *Ann. de Chim. et de Phys.*, vol. 9, p. 71, 1843.

in vacuo. Reference is made by Langley to the experiments of H. Muraoka in 1896, on lampyrid beetles collected in Kyoto in Japan, who found that these insects emitted both actinic and Rontgen rays, which acted through cardboard and could also be deflected (*Wied. Ann. Phys.*, vol. 59, pp. 773—781).

Radium bears the same relation in its combinations with the halogen and oxygen elements as calcium and thorium in their combinations with the same elements. Now no chemist will be found to affirm that elementary calcium and thorium are the principal agents in the production of the oxyhydrogen (lime) light, or the same light from Welsbach thoria mantles. The conclusion may therefore be justly drawn that elementary radium plays the like subordinate part when in combination with the negative elements, and that these elements are the principal, if not the sole cause of the phenomena of radioactivity manifested in radium combinations.

Considering the fact that, when positive and negative elements of the series Hn and H2n enter into active combination, the resultant compounds possess but few of the chemical and physical properties which characterize their components, the persistency with which the properties of radium compounds have been attributed to elementary radium is as interesting, psychologically, as the physiological effects of its compounds on the human body and on other living structures.

The incidence of the discovery of these properties, prior to the isolation of the element, has doubtless largely contributed to the illusion that they are wholly inherent in radium itself.

The announcement made three years since by Sir W. Ramsay and Mr. Soddy of the transmutation of radium,

through its halogen combination, into helium was naturally received by chemists with some degree of scepticism and incredulity. The peculiar circumstances, however, under which the transmutation was effected through Rutherford's previous suggestion that the emanation from a radium compound might resolve itself into helium, brought with it an amount of conviction sufficient to establish the reality of the transmutation in the minds of those who had closely followed the course of the investigation.

More recently, Himstedt and Meyer,[1] Giesel[2] and others, by exhaustive and decisive methods, have confirmed the experimental results previously obtained by Sir W. Ramsay and Mr. Soddy, so that the transformation of radium combinations into helium has now the certainty of any well established fact in the natural sciences.

I may here be permitted to express my satisfaction on the confirmation of the views and previsions advanced in my former papers, especially in connection with the transformation of radium into helium, and the places assigned to these elements in my tables previous to their discovery.

In the first demonstration of the transformation of radium bromide into helium, Sir W. Ramsay was careful to point out that the transformation was not brought about directly, but through a gaseous emanation evolved from the radium bromide. He describes the emanation as a new elementary substance resembling members of the argon family in its chemical inertness. Hence, we have an actual transformation of radium bromide into the elementary emanation. Now, as no suggestion has been made that elementary bromine was evolved in a

[1] *Ann. d. Physik*, Sept., 1904, Sept., 1905.

[2] *Berichte*, vol. 38, p. 2299, 1905.

free state during these changes, we are confronted with the fact that both bromine and radium are indirectly and simultaneously transformed into helium. Again, Himstedt and Meyer[1] in their first experiments on the formation of helium from the radium emanation employed the sulphate, heated to a bright red heat in an exhausted quartz tube, which showed the red, yellow, green, and blue lines at the end of three weeks, increasing in brightness the following fortnight. Hence, we have the transformation of sulphur and oxygen into helium, as in the instance of bromine into helium from the bromide emanation. Moreover, as the transformations of three of the eight members of the electro-negative series of elements into helium have been effected, there is reason for assuming that the radium combinations of the other five members may also be transformed into helium, or ultimately into hydrogen.

A great hindrance to investigators of radio-transformation products through their blind adoption of periodic systems, is the notion that the higher members of different series of elements may be transformed directly into each other, viz., uranium into thorium or into radium. These investigators might derive profit by comparing the natural series of elements in my tables with the analogous diagram in connexion with Chapter 4 of Darwin's "Origin of Species." No naturalist would entertain for a moment the notion of the transformation of a high member of one species into a high member of another species, *e.g.*, a tiger into a giraffe, except by reversion in continuity to the original type. It would be necessary to revert to the age of the Greek mythologists and to the writings of the alchemists for precedents for the belief in the direct

[1] *Ann. d. Physik*, 15, 1, Sept., 1904.

transformation of higher members of different species directly into each other.

While it is universally admitted that elementary substances and their combinations have structural arrangements of their internal parts (static or stato-dynamic) which distinguish the properties of the members of one species from those of another, the discovery of the spontaneous transformation of radium combinations into helium has clearly demonstrated that the "constitution of matter" is not necessarily atomic, in the sense generally accepted by chemists, and that the atoms of Newton and Dalton are not the immutable entities which they postulated them to be. It is, however, a profound error to suppose that the lustre of Dalton's reputation is at all diminished by the supersession of his atomistic philosophy, and great injustice would be done to his memory by this supposition. Dalton's abiding reputation rests upon his discovery and experimental demonstration of the law of chemical combination in definite and multiple proportions (in units of hydrogen), through which the law of definite and multiple proportions of the elements among themselves (with their consequent transformations) is the orderly and natural development.

The resolution of the radium-bromide emanation into helium necessarily raises the question whether the distinction hitherto made between elementary substances and their chemical combinations has a real foundation in nature, or is only an arbitrary division arising from ideas of composition derived from mechanical mixtures used in the common arts of life, as set forth in connexion with the following extract from my first paper on elementary substances[1]:—

[1] *Proc. Manch. Lit. Phil. Soc.*, vol. 17, p. 194, and *Memoirs*, vol. 10, pp. 123—4, 1887.

"Although it is herein assumed that hydrogen is the "ponderable base of all elementary species, it is probable "that this element itself, as further maintained by Prout, "may have been evolved from an ethereal substance of "much greater tenuity. Further knowledge of the outer "regions of the solar atmosphere and of the zodiacal light "may possibly indicate the steps by which hydrogen was "formed.

"I would also observe that the term 'molecule' is "here used only in the sense of a larger or denser particle "of matter, and does not imply the idea of a composite "aggregation of the separate particles, each preserving its "distinctive character after the molecule is formed, any "more than rain-drops preserve their distinctive character "after falling into the ocean. It appears to me much "more in accordance with the truth of nature to suppose "that the smallest conceivable particle of a chemical "substance or compound has the same physical properties "absolutely as the mass. If it be objected that such an "union of particles would have relations of infinity, and is "therefore inconceivable, it may be answered that the "central particles of a rotating body have mathematical "and physical relations of a similar kind, and as the "instrument of thought is incapable of forming a distinct "conception of the magnitude of the infinitesimals in-"volved in a centre of rotation, still less is it capable of "comprehending the mode of union of the unknowable "essences on which the physical qualities of chemical "substances, after combination, depend. Philosophical "chemists, I apprehend, will hereafter be able to refer the "origin of the theory of the composite structure of matter, "after chemical union, to the influence of ideas derived "principally from the mechanical mixtures employed in "pharmacy and in the culinary art."

Although many years have elapsed since the above paragraphs were written, I have found no sufficient reason to change the opinions expressed therein, but, on the contrary, much to confirm the conviction that the ultimate constitution of all substances, including the universal medium (ether) that fills infinite space, is absolutely inscrutable to human understanding. Not the least valuable result of the study of mental philosophy is the conscious realization of its limitations. Mathematical science has no monopoly in the production of mental wreckage, through the vain endeavours of some individuals to measure the incommensurables in geometry and in numbers, and similar dangers beset the path of unwary investigators of the, as yet, obscure phenomena of radio-activity and atomic subdivision. A distinguished cultivator of natural knowledge, Sir W. R. Grove, in his epoch-marking book on the "Correlation of Physical Forces,"* has expressed himself in similar terms with reference to the limitations of man's knowledge of the ultimate structure of "matter," and "the harm done by attempting hypothetically to dissect it, and to discuss the shapes, sizes, and numbers of atoms and their atmospheres of heat and electricity."

The doctrine that dynamic forces in molecular physics are modes of motion mutually transformable, or, in other words, *qualities* of substance and not specific entities, is fully accepted by all who are versed in the history of natural and mental philosophy. Nevertheless, some eminent writers on radio-activity and sub-atomic mechanics fail to recognize the results of the labours of the eminent philosophers who have established this doctrine on a firm basis, as they revert to the corpuscular notions prevalent in the seventeenth century, and discuss "atoms

*5th Edition, 1867.

of electricity," *i.e.*, of motion, and combinations of "atoms of electricity" with matter. For such writers, Bacon, Locke, Davy, Faraday, Joule and Mayer might never have lived, and the "Correlation of Physical Forces" might never have been written.

Addendum.

The series H2n possesses some features of local geological interest from the fact that, in the north-western parts of the adjoining county of Derbyshire, the mineral masses consist chiefly, and contain the chemical combinations of magnesium, calcium, zinc, strontium, cadmium, barium, and lead, all of which, except magnesium and strontium, are mining products of the district. These include fluor-spar (calcium fluoride), lime (calcium oxide), gypsum, (calcium sulphate), blende (zinc sulphide), calamine (zinc silicate), cadmium sulphide, baryta (barium oxide), barytes (barium sulphate), and galena (lead sulphide). Lead mines have been worked from the time of the Roman occupation, in close association with the other combinations of the series H2n. The hot spring of Buxton has been shown by Mr. Strutt to give off radium emanation, and may presumably yield helium, as was recently found in the similar hot spring at Bath by Lord Rayleigh.

The occurrence of nearly all the members of the same series of elements within so limited an area, clearly indicates them as evolutionary products of the typical member, helium, at the head of the series H2n.

iple Proportions, 1878—1894—1902—1903—1906.

H4*n*	H5*n*	H6*n*	H7*n*	
			Ne = 7	
— = 16	B = 10 ·· ·· 11 2·63	— = 18	N = 14 Ar = 21 Kr = 42 Xe = 63	
— = 32	P = 30 ·· ·· 31 1·82	— = 36	Si = 35 28 : 35 2·49	
Ti = 48 ·· ·· 48 4·1‡	V = 50 ·· ·· 51·2 5·5	Cr = 54 ·· ·· 52·4 7·3	Fe = 56 Mn = 56 Ni = 56 Co = 56	56—8·14‖ 55—8·00 58—8·66 58—8·96
Ge = 72 ·· ·· 72·7 5·47	As = 75 ·· ·· 75 5·63			
Zr = 92 ·· ·· 90 4·15? 5·4‡	Nb = 95 ·· ·· 94 6·67	Mo = 96 ·· ·· 96 8·6		
Sn = 116 ·· ·· 116 7·29	Sb = 120 ·· ·· 120 6·72		Pd = 105 Rh = 105 Ru = 105 Da = 105	105·6—12·0 104·4—11·2 104·4—11·4 ··· ···
La = 140 ·· ·· 139 6·7	*x* = 140 ·· ·· ·· 8·15‡	*x* = 144 ·· ·· ·· 10·0‡		
x = 164 ·· ·· ·· 9·11‡	*x* = 165 ·· ·· ·· 8·30‡			
D = 188 ·· ·· 95 8·0‡	Ta = 185 ·· ·· 182 10·78? 9·8‡	W = 186 ·· ·· 184 18·26		
U = 240 ·· ·· 240 18·4	Bi = 210 ·· ·· 210 9·83		Au = 196 Pt = 196 Ir = 196 Os = 196	196—19·34 197—21·50 198—22·42 198—22·48

mated. §Anthracite. ‖Electro-deposited.

of Wurtz, Roscoe and Schorlemmer, J. P. Cooke, F. W. Clarke.
pp., p. 247—Atomicity.

Elementary Substances, with their Atomic Weights in Mult

	+Hn—		+H2n—		H3n
1	H = 1		He = 2		
2	Li = 7 7* 0·59†		Gl = 8 9·2 1·64? 1·3‡		C = 12 12 1·71§
3	Na = 23 23 0·98	F = 19 19	Mg = 24 24 1·74	O = 16 16	Al = 27 27 2·56
4	K = 39 39 0·86	Cl = 35 35·5 1·3	Ca = 40 40 1·58	S = 32 32 2·05	Sc = 42 44 3·4
5	Cu = 62 63·3 8·9		Zn = 64 65 7·2		Ce = 69 92 : 141 6·5
6	Rb = 85 85 1·52	Br = 81 80 3·0	Sr = 88 87·5 2·54	Se = 80 79·4 4·8	Ga = 96 70 5·95
7	Ag = 108 108 10·6		Cd = 112 112 8·69		Y = 123 61·7 : 89·5 8·1‡
8	Cs = 131 132 1·88	I = 127 127 4·95	Ba = 136 137 3·75	Te = 128 128 6·3	In = 150 75·6 : 113·4 7·42
9	x = 154 12·2‡		x = 160 10·13‡		Er = 177 17c 9·4‡
10	x = 177 2·2‡		Ra = 184 4·8‡		Tl = 204 204 11·85
11	Hg = 200 200 13·6		Pb = 208 207 11·44		Th = 231 23 11·23

*Accepted Atomic Weights. †Specific Gravities.

*** The accepted atomic weights are taken from the standard works and is and Watts' "Dict. Chem.

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III. A Journey to North-east Rhodesia during 1904 and 1905.

By S. A. NEAVE, M.A., B.Sc.,
Naturalist to the Geodetic Survey.

(Communicated by Dr. W. E. Hoyle, F.R.S.E.)

Received and read October 30th, 1906.

I left England early in 1904 as Naturalist to the Geodetic Survey of North-Eastern Rhodesia. For this I am indebted to the great generosity of Mrs. Stoehr and her son, Dr. F. Stoehr, medical officer to the Expedition, and also to the British South Africa Company, whose guest I had the honour of being. I also received considerable assistance and encouragement from the Committee of the Manchester Museum. Finally, I must express my unbounded gratitude to Mr. Robert Codrington, the administrator, and the other officials of the Company, who, wherever I went, greeted me with the greatest hospitality and gave me every possible assistance.

Landing at Chinde, one of the mouths of the Zambesi, a three weeks' journey, via Tete, brought me to Fort Jameson, the seat of the Administration. After some little delay, owing to difficulties of transport, I travelled down to Feira, at the junction of the Zambesi and Loangwa rivers. Here I met with some of the other members of the survey. Here also I was able to start serious collecting, having now assembled together my apparatus, much of which had not accompanied me from Fort Jameson, but had come direct from Tete.

January 24th, 1907.

I spent a short time on Mt. Kapsuku on the south bank of the Zambesi. Thence, having obtained a supply of carriers, I travelled some 60 miles along the north bank of the river, and made a short stay at this point, collecting specimens on both banks of the river. Thence I moved in a north-easterly direction, travelling very slowly, crossed the Loangwa at Ntambwa's, some 40 miles above Feira, into Portuguese territory. Here I spent about a month and a half travelling slowly about. By this time the dry season, which lasts from about the beginning of April to the end of October, was at its height, and animal life was relatively speaking not very abundant.

Early in October I returned to Ntambwa's on the Loangwa, where I found the members of the survey at their base camp.

The rains were now imminent, and two weeks later I deemed it advisable to start for Petauke, some 120 miles to the N.E., which was reached at the beginning of November. This place being but little to the east of the route the survey proposed to take, I had selected it for my base. This charming spot is a government station, Mr. H. S. Thornicroft being the Native Commissioner, and it was not a little due to his kindness and hospitality that I was able to do a large amount of work there. With the exception of a few short excursions in different directions, I made no journey of any importance until the middle of April, 1905. The rainy season being then over, I started in a S. Easterly direction, through the thickly populated Mbala country, a more open district than I had previously met with. Travelling slowly nearly to the Portuguese border, I turned westward, and crossed the Loangwa river. After visiting members of the survey not far from the west bank, I returned to that river, and spent

a considerable time amongst the abundant fauna on its banks. Retracing my steps somewhat, and with many halts, I returned to Petauke at the end of July to refit. After a short excursion northward, I started at the end of August on a trip I had long contemplated to the high plateau country west of the Mchinga range. Having crossed the Loangwa and Lukashashi rivers, which are separated by the Niamgoza mountains, a further 30 miles brought me to the well marked escarpment of the Mchingas.

Upon the plateau, which extends to the Kafue and beyond it, I found a very different fauna, as the collections will, I think, show. The boundary between N.E. and N.W. Rhodesia has been recently changed, and this part of the country is now under the latter administration.

Travelling slowly in a N.W. direction, through a thinly populated but magnificent country, with abundance of running streams, I reached the new Government station at Ndola, close to a large native village known as Chewallas. Here I was most hospitably received by Mr. J. E. Stephenson, the Native Commissioner.

Leaving this place I turned S.W. and struck the Kafue river (there locally called the Livu) some 50 miles below its source. Thence I travelled southwards to Kapopo an old government post now deserted and spent some days at a remarkable limestone pool at no great distance from that place. This pool which is probably due to a subsidence in the limestone, is roughly square, the length of a side being about 200 yards. It lies in the midst of a flat piece of country and has precipitous sides. The surface of the water, at this, the driest season of the year, was some 15 feet below the top of the walls. Attempts were made to sound it, but although 300 feet of rope were used, bottom could not be found at that depth,

even near the edge. The water itself was intensely still, cold, and pellucid. It was full of fish, but I was unsuccessful in catching them on a rod and unfortunately had no other means at my disposal. The local natives look upon the pool with great suspicion and will not even drink its water.

My time being now short I turned eastward and having crossed my old route, took a more northerly course. After a somewhat difficult journey owing to shortage of food supplies for my carriers, through a fine but mountainous country the Loangwa was crossed, and Petauke reached at the end of November. After one or two short expeditions, I left Petauke for Fort Jameson early in January, 1906, and thence reached the coast, travelling through British Central Africa, via Lake Nyassa and Blantyre.

Wherever I went I met with friendly, peaceable, and for the most part prosperous natives. This is not a little remarkable, and reflects great credit on the Administration, when one considers that less than ten years before the country was entirely unadministered and was overrun with slave dealers and raiders, the weaker tribes being in daily peril from the attacks of the stronger. The people of the Loangwa valley in particular are a remarkably industrious, tractable, and law-abiding race. They are also great agriculturists. They mostly belong to the Senga tribe, with some admixture of Chikunda and Angoni stock. Westward, on the plateau, the people belong to the Alala tribe, and westward again to the Kafue, the Alamba are found. The two latter tribes differ very much in their method of agriculture from the peoples of the Loangwa valley. Their gardens are renewed every year instead of every two or three, and they further cut down and destroy five or six acres of bush

land for every one that they actually cultivate. This they do in order to obtain sufficient timber to burn on the cultivated patches. This is a serious matter for the future of this part of the country, and though it is difficult, efforts should be made to teach the natives to cultivate the highly fertile but somewhat swampy lower ground which abounds in many parts of the plateau, with maize instead of sorghum and millet, which at present form their main crop. Want of space prevents me from considering further the natives of the country, who are nevertheless remarkably interesting.

Three rather distinct types of country were met with.

(1) The low country up to 2,000 feet, such as is found in the valley of the Loangwa and of the Zambesi at the point where the former river joins it. This is characterised by patches of typically tropical vegetation, with palms, etc; by areas of more or less dense thorn scrub; by sandy flats covered with Copaiferous "mopani" trees, varied by small open spaces, but remarkable for the absence of undergrowth. This country breaks up in many places toward the foot hills into stony ridges, with comparatively thin vegetation.

(2) The country from 2,000–3,000 feet is mainly of a broken and hilly character, and a large part of it, including nearly all the hills, is covered with a thin woodland. Large timber is not usually met with, except on the banks of streams. Here and there are open spaces, locally known as "dambos," covered in the rainy season with immensely tall grass.

3 Above 3,000 feet the woodland is of similar character, but less in extent, the open grassy spaces being markedly larger. Here and there in places granite kopjes may be seen. On the high plateau towards the Kafue parts of the country exhibit the well-known park-

like character so often described by African travellers. There are also patches of dense jungle, mainly composed of evergreen trees, and usually found on the banks of streams.

There can be but little doubt that the annual bush fires in the dry season, universal in this country, have had a marked effect upon the flora, and to a less extent the fauna, of this part of Africa. It is perhaps one of the reasons why fine timber, except near water, is extremely scarce.

The collections made cover most of the orders of the animal kingdom, and detailed accounts of the more important groups will shortly be published.

An opportunity of returning shortly to Central Africa prevents me from myself publishing an account of some of the Lepidoptera, in addition to the Birds, as I had hoped to do. I am glad to say, however, that I have been able to leave this part of the work in the competent hands of my friend, Dr. F. A. Dixey, of Wadham College, Oxford.

I was unable through lack of time to make a large botanical collection. Flowering plants I found chiefly conspicuous at the higher elevations, and at the beginning and after the end of the rains, *i.e.*, the Spring and Autumn of the year.

I made a somewhat large number of notes upon native names of the specimens collected. They are mainly the names used by the Manganja, Achawa, and other Lake Nyassa tribes and those of the Asenga in the lower Loangwa valley. A few were obtained from the Alala and Alamba people on the plateau. The average native's knowledge of the Fauna of his country is remarkably good, though individuals vary very much in this particular.

In conclusion I would remind Zoologists that Natural History collecting in Tropical Africa is a very different matter from similiar work in more temperate latitudes. The labour of preserving specimens from Ants, Termites, small Rodents and other foes is nearly as great as that of collecting them. Further from the nature of the life and methods of travel, pleasant though it is, one's working day is necessarily a short one, especially when on the march. The very fact of travelling about, accompanied by some 50 or more natives, in itself entails attending to endless little matters, which nevertheless cannot be neglected.

R. Luangwa
R. Luangwa
Chimundo
Fort Jameson
ACHEWA
ANGONI
Lawnges
ACHIRETA
AZIMBA
MISALE
NYANJA
CHEWA
NDOLA
Mkuwa
Mfuwe
Chipata
Petauke
MBALA COUNTRY
Nyasa
PORTUGUESE
EAST
AFRICA
TETE
MOIRS
BERENJE
Kapoche
CHIWALIS
R. Mchenja
R. Lukusuzi
MT. ULUNDO
ACHRUNDA
Nyalgwe
MT. PAKOLWE
Zambezi
River
FEIRA
MT. KAPUNDU
SOUTHERN
RHODESIA
R. Kafue
Mkushi
R. Lusemfwa
Mkushi
R. Lukusashi
Mulungushi
Broken Hill
Mumbwa
Lusaka
Kabwe
BWANA M'KUBWA
NORTH WESTERN
RHODESIA

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IV. Notes on a Collection of Terrestrial and Fluviatile Mollusca, made in North-Eastern Rhodesia, during 1905, by Mr. Sheffield A. Neave, M.A., B.Sc.

By JAMES COSMO MELVILL, M.A., F.L.S.,

AND

ROBERT STANDEN,

Assistant Keeper, Manchester Museum.

(Received and Read November 27th, 1906.)

The collections of mollusca formed by Mr. Sheffield A. Neave a year ago (1905), mainly in the neighbourhood of the Loangwa and Kafue Rivers, North-Eastern Rhodesia, are more remarkable for quality than quantity, being select indeed both in numbers and the material gathered.

Geographically, this section of Rhodesia, situate, roughly speaking, long. 28 50′ to 34 E., lat. 8 50′ to 16 S., impinges on the West on the vast Congo Free State, Northeastward on German East Africa, and due East on British Central Africa and Nyasaland. As Dr. Pilsbry* well remarks, the "West African *Achatinæ* are "usually more richly coloured than the East African, "and are more diversified in form, size, and coloration. "No species are yet known to be common to the West "and the Lake region or East coast." And what is here said concerning the large Agate snails may be held good for the majority of the other families of mollusca.

The productions of Rhodesia may best, we think, be compared with those of German East Africa, a vast

* "Man. Conch.," vol. 17, p. 5.

area indeed, but which during the past twenty or more years has been especially studied, and the results given to the world in such classical treatises as Dr. Eduard von Martens' "Beschalte Weichthiere Ost-Afrikas" (1897). In this the author, whose recent demise has been universally deplored, names about 420 species as occurring in that region, a number now considerably augmented. Another work of great interest is that of J. R. Bourguignat, "Mollusques de l'Afrique équinoctiale" (1889). M. M. Dupuis and Putzeys have mainly studied the mollusca of the Congo basin, while the late C. F. Ancey*, in a more general way, has described many species from several tropical areas. Lastly, Mr. Edgar A. Smith, I.S.O., has published much on the subject during the past five and twenty years, and to him we are now especially indebted for having examined, in our company, the whole of Mr. Neave's gatherings, and given the benefit of his advice and past experience with regard to them. Our thanks are also due to the authorities of the Manchester Museum, for having requested us to undertake the following enumeration, and placing all facilities in our way. The types will be placed in the Manchester Museum.

LOCALITIES VISITED.

Mr. Sheffield Neave writes regarding this:—

Petauke. The majority of the mollusca collected came from Petauke or its immediate neighbourhood. This is the Government Station of the westernmost section of the East Loangwa district, and lies some 25 miles east of that river, and some 600 feet above it. Elevation about 2,400 feet.

The country here is mountainous and wooded *Burtoa arnoldi* (*nilotica*) and the *Achatinæ* generally are

*It was whilst writing this present paper that we heard, with much regret, of the death of M. Ancey, in the autumn of 1906.

found on the ground after heavy rains. I never met with living specimens during the dry season, viz., from April to October.

Mterize River. The Mterize River is a tributary of the Loangwa, and flows 50 miles South of Petauke, through well-wooded and hilly country. Elevation, 2,000 feet.

Loangwa River. A few species came from the main bed of this important river, say at lat. 15 30'. Elevation, 1,700 feet.

The neighbourhood of this river and its tributaries was found poor in mollusca, perhaps owing to the scarcity of limestone.

Alala Plateau. The Alala Plateau lies due West of the Mchinga escarpment. More open country prevails here, with large stretches of grass land. (September 15—20, 1905.) Elevation 4,000 feet.

Kafue River. A few shells were collected on the banks of a small stream at Ndola, a Government Station near the Katue River. The country is fairly open, but with patches of very dense forest in the proximity of streams. Elevation 4,000 feet.

*Kapopo.** The famous limestone pool near Kapopo was visited 26th and 27th October, 1905. Judging by the great abundance of dead shells, mollusca must here be plentiful as regards individuals, though the number of actual species is apparently very limited. Country more or less open, with forest-patches as at Ndola, and about the same elevation (4,000 feet). Mollusca are known to the natives as "Mkorno," and many of the larger terrestrial species are dried and eaten by the people of the Alamba Tribe in this neighbourhood (Kapopo, but not, so far as can be ascertained, elsewhere. S. A. N.

*N.B.—In Keith Johnston's Atlas (Ed. 1905) Kapopo is spelt Chepopo.

We may add that, although this very interesting collection is small numerically, yet but few similar gatherings from tropical Africa made at one time and under similar circumstances much exceed it in actual count of species.

Vast numbers of individuals, identical specifically, occur in certain favoured spots, accumulated together and gregarious, but there does not seem to be the wealth of variety that is obtainable in many other parts of the world, several of them of lesser area, if such an exceptional locality as Lake Tanganyika and its peculiar quasi-marine fauna be not taken into account.

CLASS GASTROPODA.

Fam. CYCLOSTOMATIDÆ (Pomatiasidæ).

Pomatias nyassanus, Smith.

Pomatias nyassanus, E. A. Smith, *Proc. Zool. Soc. Lond.*, 1899, p. 591, pl. 35, fig. 5.

Hab. Petauke; living good examples at 2,400 feet. Mterize River, Loangwa, one, dead, at 2,000 feet. Also good, but dead, specimens from the banks of the Loangwa River, lat. 15° 30′, at 1,700 feet.

This species is conspicuous for its many close and prominent spiral carinæ. In this it to some extent approximates to *P. transvaalensis* (M.&P.) and *P. pluriliratus* (Fulton), both species occurring further South, but the riblets on these latter species are not so pronounced. It is really nearer *P. insularis* (Rve) or *P. hæmastoma* (Anton). *P. letourneauxi* (Bgt.) and *P. zanguebaricus* (Petit) from contiguous neighbourhoods, are likewise akin. It is probable several of these species occur in Rhodesia.

Fam. VIVIPARIDÆ.

Cleopatra mterizensis sp. n. (Fig. 2 of Plate).

Cl. testa angustè umbilicata, ovato-oblonga, lævigata, solidula, pallidè straminea, anfractibus 6, tumidulis, quorum apicales brunnei, læves, tribus infrá apud medium acutè spiraliter carinatis, ultimo anfractu carina conspicua ad medium, utrimque obscurè spiraliter angulato, quasi-tricarinato, apertura ovato-rotunda, peristomate continuo, ferè rotundo, tenui, margine columellari paullum incrassato.

Alt. 14. Diam. 8 mm.

Hab. Bed of Mterize River, a tributary of the Loangwa River.

A plain little species, with the upper whorls once spirally keeled, the penultimate twice, the lower carina only just above the suture, and partially obscured by the growth of the body whorl, this latter being provided with a central keel, and a rudimentary one on each side, causing the semblance of two slight angles. No colour zones are visible, this and the straw-coloured surface being perhaps both owing to a bleached condition. In form and general appearance *C. bulimoides* Oliv. is approached, but that species is never carinate.

Cl. emini E. A. Smith (*Proc. Zool. Soc. Lond.*, 1888, p. 54, fig. 2) is nearer. This species is considered by von Martens synonymous with *Cl. pirothi* Jickeli (1881), this name having thus a priority of seven years. Here the keels are very acute and distinct, blackish brown on a pale ground, and the body whorl decidedly bicarinate. The form is gradate, and not in the least ventricose, as is *Cl. interizensis*. And, lastly, *Cl. johnstoni*, E. A. Sm. (*Proc. Zool. Soc. Lond.*, 1893, p. 637, pl. 59, fig. 9) differs entirely in sculpture, not being therefore in any degree comparable.

Fam. AMPULLARIIDÆ.

Lanistes affinis Smith.

Lanistes affinis, E. A. Smith, *Proc. Zool. Soc. Lond.*, 1877, p. 716, pl. 74, fig. 7.

Lanistes ovum Pet. *var. affinis*, E. A. Smith; E. von Martens "Beschalte Weichthiere Deutsch-ost-Afrikas," p. 166.

Hab. Mterize River, Loangwa, July, 1905, and Zambesi River.

Seems to us a distinct species. Some fine examples from Nyasa are in the British Museum. Mr. Neave's examples are characteristic, but small.

Lanistes neavei sp. n. (Figs. 1 and 3 of Plate).

L. testa sinistrorsa, ovato-rotunda, solidula, profundé umbilicata, albo-cinerea, spiraliter arcté multi-zonulata, zonulis variis, sæpe apud basin anfractus ultimi evanidis, anfractibus 5, ad suturas multum impressis, infra suturas paullum planulatis, deinde ventricosis, lineis incrementalibus arctis longitudinaliter in speciminibus adultis, præcipué ad anfractum ultimum, fortiter præditis, apertura feré rotunda intus, ut extus, zonulata, zonulis ultrá marginem interiorem evanidis, peristomate paullum incrassato, albo, nitido, continuo, margine columellari obliquato.

Alt. 20. Diam. 25 mm. spec. maj.

Hab. Kapopo, Oct. 26th, 1905.

A considerable number of examples, mostly somewhat immature. These latter are smoother and more shining, clearly exhibiting the characteristic spiral brown-zoned marking, especially on the body whorl. Two examples of a variety occurred in which these zones are entirely absent, these might be designated as var. *unicolor* (Fig. 3). It gives us much pleasure to connect with this interesting

form, of which unnamed examples from Nyasa exist in the British Museum (Nat. Hist.), the name of its discoverer, Mr. Sheffield A. Neave.

Lanistes ovum Peters.

Lanistes ovum, Peters; Troschel, *Archiv f. Naturgesch.*, Jahrg. 11, vol. 1, p. 215, pl. 6, fig. 11, 1845.

Hab. Banks of a small stream at Ndola, at 4,000 feet alt

Two living examples with opercula. Both seem juvenile, and we are not quite sure of the identification. The species undoubtedly would occur in Rhodesia, being widely distributed, and reported also from Delagoa Bay, to Tanganyika and Nyasa.

Fam. MELANIIDÆ.

Melania tuberculata O. F. Muller.

Nerita tuberculata, O. F. Muller, "Hist. Verm.," vol. 2, p. 191, 1774.

Melanoides fasciolata, Olivier, "Voy. Emp. Ottoman," vol. 2, p. 40, pl. 31, fig 7.

Melania tuberculata (Mull.); Philippi, "Abbild. neuer Conch.," vol. 1, pl. 1, fig. 19.

Hab. Bed of Mterize River, a tributary of the Loangwa. May 23, 1905.

One of the most widely distributed of all tropical or subtropical molluscs. The original types came from the Coromandel Coast. It is reported as far south as the Transvaal, and will very probably be found in Natal.

Fam. LIMNAEIDÆ.

Planorbis bowkeri Melvill and Ponsonby.

Planorbis Bowkeri, Melvill and Ponsonby, *Ann. Mag. Nat. Hist.*, (6), vol. 12, p. 111, fig. 19, 1893.

Hab. Bed of Mterize River, May 23, 1905. Also from Ndola, Kafue River, at 4,000 feet.

A small *Planorbis*, allied to *P. natalensis*, Krauss, but of inferior size, with the disks both more deeply excavate proportionately. Described originally from examples collected in the Transvaal by Colonel Bowker (E. L. Layard). This shews a great northward extension of its range.

Fam. PHYSIDÆ.

Physopsis africana Krauss.

Physopsis africana, Krauss, "Südafrik. Mollusken," p. 85, pl. 5, fig. 14, 1848.

Hab. Bed of Mterize River, May 23rd, 1905. Also in the Kafue River, near Ndola.

A well-known tropical and South African species, occurring as far south as Natal. Our specimens seem intermediate between the type and *P. ovoidea* Bgt., which surely can be but a variety. This latter shell is figured by von Martens (*l.c.* pl. 6, fig. 13).

Fam. TESTACELLIDÆ.

Streptaxis nseudweensis Putzeys.

Streptaxis nseudweensis, Putz., *Ann. Soc. Malac. Belgique*, vol. 34, *Bull.* p. lv. fig., 1899.

Petauke, at 2,400 feet.

One specimen only, immature. The species is beautifully longitudinally striate on the upper portion of the whorls.

Distrib., Congo, W. Africa.

Fam. LIMACIDÆ.

Helicarion nyassanus Smith.

Helicarion nyassanus E. A. Smith, *Proc. Zool. Soc. Lond.*, 1899, p. 582, fig. 9.

Var **excellens** nov. (Fig. 7 of Plate).

Hab. Petauke, 25 miles E. of Loangwa River, at 2,400 feet.

Several examples, mostly with the animal, all agreeing in deviation from the type by greater planulation or flattening of the upper portions of the whorls. The nearest approach to this species seems to be *H. caillaudi* Morelet*, a form likewise planulate, but not quite to the same extent.

Martensia mossambicensis (Pfeiffer).

Helix mossambicensis Pfeiffer, *Proc. Zool. Soc. Lond.*, 1855, p. 91, pl. 31, fig. 9; "Mon. Helic.," vol. 4, pl. 32.

Nanina (*Trochomorpha*) *Mossambicensis* (Pfr.), v. Martens, *Mal. Blätt.*, vol. 6, p. 211, &c., 1859.

Martensia mossambicensis Semper, "Reis. Archip. Philippin.," part 2, vol. 3, p. 42, pl. 3, fig. 5; H. Godwin-Austen, *Proc. Mal. Soc. Lond.*, vol. 1, p. 281, pl. 19, figs. 1—1*e* (anatomy), 1895.

Trochonanina mozambicensis Mousson, *Journ. de Conch.*, vol. 17, p. 330, 1869; Bourguignat, "Moll. Afrique équat.," p. 17; E. A. Smith, *Proc. Mal. Soc. Lond.*, vol. 1, p. 164, 1894.

Hab. Petauke. February 19, 1905, and near Loangwa River, June 12, 1905.

A fine variety of this widely distributed and common species, conspicuous for its very fine microscopical spiral concentric striæ, omnipresent over the whole surface, especially conspicuous towards the base. Most varieties of *M. mossambicensis* are smooth basally. Of the several varietal names imposed, Mr. Neave's specimens most assimilate *M. nseudweensis* Dup. and Putz.

*C.f. von Martens "Ost Afrika," pp. 37, 38, pl. 1, f. 4, and pl. 3, f. 2.

Fam. PUPIDÆ.

Ena (Rhachis) melanacme (Pfeiffer).

Bulimus melanocme, Pfeiffer, *Proc. Zool. Soc. Lond.*, 1855, p. 96, pl. 31, fig. 8; *Id.*, "Monogr. Helic. viv.," vol. 4, p. 486.

Bulimus (*Rhachis*) *melanacme* (Pfr.), von Martens in Albers, "Heliceen," ed. 2, p. 231; *Id.*, *Nachr. deutsch. mal. Ges.*, 1869, p. 152.

Pachnodus sesamorum, Bourguignat, "Moll. Afrique équat.," p. 66, pl. 3, figs. 2, 3, 1889.

Hab. Petauke, March 15, 1905.

A living, but not quite mature example, well coloured, and shewing the brown spiral zones so characteristic of the species, as also the black apex, from which it takes its specific name.

Ena (Rhachis) sticta (v. Martens).

Bulimus (*Rhachis*) *stictus*, E. von Martens, *Mal. Blätt.*, vol. 6, p. 211. pl. 2, fig. 6, 1859. Pfeiffer, "Monogr. Helic. viv.," vol. 6, p. 131.

Hab. Petauke, March 15, 1905.

Though dead in condition, referred without much doubt to this species, a very characteristic and easily discerned one, described originally from Mozambique.

Fam. STENOGYRIDÆ.

Limicolaria sp.

Hab. Kapopo, October 26, 1905.

One perfect, but somewhat bleached representative of this genus, which may, perhaps, be a form of *L. saturata*, E. A. Smith.* The head quarters of this latter seem to be the Victoria and Albert Edward Nyanza districts. At the latter locality it was discovered by Mr. G. F. Scott-Elliot in 1894.

* *Proc. Mal. Soc. Lond.*, vol. 1, p. 323, fig. 1, 1895.

Burtoa nilotica (Pfeiffer).

Bulimus niloticus Pfeiffer, *Proc. Zool. Soc. Lond.*, 1861, p. 24; *Mal. Blätt.*, vol. 8, p. 14, 1862.

Limicolaria nilotica Pfr., "Novitat. Conch.," vol. 4, p. 5, figs. 1—3. (var. *Schweinfurthii* inclusa.)

Achatina nilotica von Martens, *Mal. Blätt.*, 1870, p. 22.

Burtoa nilotica Brgt., "Moll. Afrique équat.," p. 89, March, 1899.

Livinhacia nilotica Crosse., *Journ. de Conch.*, 1889, p. 109.

Lirinhacia arnoldi Sturany, "Südafrik. Mollusken," p. 59, 1898.

Hab. Petauke.

Many varieties of this large and imposing mollusc are described and figured by various authors, notably von Martens* and Bourguignat. The latter, indeed, has unduly created a new genus (*Burtopsis*), besides several so called species, all formed out of the *B. nilotica*, and the remarks of Mr. Edgar Smith,† in reference to this subject, may be read with profitable interest.

The distribution is wide, extending over a very large area both North and South of the Victoria Nyanza, where seem to be its head-quarters.

Achatina craveni Smith.

Achatina kirkii E. A. Smith, *Ann. Mag. Nat. Hist.*, (5), vol. 6, p. 428, 1880, non *A. kirkii* (*Pseudoglessula kirkii*), Craven (1880).

Achatina cravenii E. A. Smith, *Proc. Zool. Soc. Lond.*, 1881, p. 283, pl. 33, fig. 11; *Op. cit.*, 1899, p. 590, pl. 35, fig. 1, 2.

Hab. Petauke, and its immediate neighbourhood, up to 2,400 feet.

A very handsome, but variable species, of fairly wide distribution, abounding in the Tanganyika, M'bwa, and Massai Countries, also in Nyasaland, and not unknown at Zanzibar.

Several examples in various stages of growth.

* "Ost Afrika," pp. 94—98.

† *Proc. Mal. Soc. Lond.*, vol. 1, p. 324.

Achatina immaculata Lamarck.

Achatina immaculata, Lamarck, "Anim. s. vert.," vol. 6, part 2, p. 128, No. 3, 1822.

Hab. Petauke, February and March, 1905.

A few examples of this old established *Achatina*, handsome, with painting of obscure longitudinal brown flames upon an almost equally dark ground. Older examples are unicolorous, and nearly smooth. By some authors the very different looking *A. layardi*, Pfr., is accounted a mere variety. We can hardly agree with this. An interesting note on the epiphragm of this species was published a few years since by Mr. Edgar A. Smith, with diagrams. (*Proc. Mal. Soc. Lond.*, vol. 3, p. 309, 1899).

The geographical distribution extends from Delagoa Bay to Nyasaland.

Achatina morrelli Preston.

Achatina morrelli, H. B. Preston, *Proc. Mal. Soc. Lond.*, vol. 6, p. 244, fig., 1905.

Hab. Kapopo, October 26, 1905.

A young, but well coloured, and living example, which occurred with the *Limicolaria* sp.

The author of the species compares it to *A. glaucina* (Ancey), Smith, from Zamba, on the Shiré River. Many examples have been shown us by Mr. Preston, the original locality being Changa Changa, Lusempha Valley, about 100 miles N. of Zumbo, on the Zambesi River, which do not exhibit an undue amount of variation. It is a very ornamental species, very strongly cancellate and decussate, excepting on the lower half of body whorl.

Achatina rhodesiaca sp. n. (Figs. 4, 5, 6, 9 of Plate).

A testa elongato-fusiformi, spira attenuata, tenui, nitida, albo-cinerea, flammis fulgetrinis obliquis castaneo-brunneis, vel fere rectis, nunc latis, nunc angustis, longitudinaliter decorata, interdum brunneo-suffusa, anfractibus ad 10, tribus apicalibus inclusis nitidis, albis, lævissimis, cæteris infrá suturas corrugato-impressis, undique tenuiter cancellato-striatis vel decussatis, ultimo anfractu paullum producto, cæteros magnitudine multum exsuperante, superné leniter decussato, infrá lævi, apertura ovata, intus caerulescente, peristomate tenui, paullum effuso, columella feré recta, apud basin truncata.

Alt 58. Diam. maj. 31. Aperturæ alt. 28. Diam. 15 mm. sp. max.

Hab. Kapopo, Rhodesia.

Over a dozen examples, in various stages of growth. This is a moderately sized, very attenuately fusiform *Achatina*, varying mainly in disposition of longitudinal chestnut brown zigzag, or nearly straight, flame markings, so characteristic a sign of African *Limicolaria* or *Achatina*.

Two varieties occur :—

(*a*) *Leucopsa*. Shell entirely colourless, white. (Fig. 9).

(*b*) *Lanceolata*. Shell much narrowed in the body whorl, being laterally nearly straight. Mouth smaller and narrower, peristome not in the least suffuse. (Fig. 5).

A certain affinity to *A. johnstoni* E. A. Sm. from Nyasaland is observable : but the coloration is different, the shell of this latter species being more convex, and more roughly granulate with incremental lines and spiral striation. It is likewise of greater size. And another species *A. capelloi* Furtado, a West African shell, of which we have seen only a figure, collected by Capello and Ivens near Quintum, seems allied to *A. rhodesiaca*.

A ivensii Furtado*, of which one specimen, probably in the Congo Free State, was collected by the same explorers, is, from the figure, of the same character as our var. (*b*) *lanceolata.*

CLASS PELECYPODA.

Fam. UNIONIDÆ.

Mutela bourguignati Ancey.

Mutela bourguignati, Ancey, "Esp. nouv. et genr. nouv. d'Oukerewe et Tanganyika," p. 8, 1885.

Hab. Bed of Mterize River, a tributary of the Loangwa, May 23, 1905.

Described as inhabiting the Victoria Nyanza.

Fam. CYRENIDÆ.

Corbicula astartina Mrts.

Corbicula astartina, v. Martens, *Mal. Blätt.*, vol. 6, p. 219, pl. 3, figs. 6, 7, 1860.

Hab. Mterize River, a tributary of the Loangwa, May 23, 1905.

Dead half valves, but quite characteristic. The species was described by Dr. E. von Martens from examples from Nyasa (J. Kirk) and also Zambesi (Peters).

Corbicula radiata Phil.

Cyrena radiata, Philippi, "Abb. und Beschr. neuer Conch.," vol. 2, p. 78, pl. 1, fig. 8, 1846.

Corbicula radiata (Phil.), H. Adams, *Proc. Zool. Soc. Lond.*, 1866, p. 376.

Hab. With the preceding.

Two valves, smaller than those of *C. astartina* Mrts., probably belong to this widely distributed and common *Corbicula*, reported from the neighbourhood of all the large African lakes by various collectors from time to time.

* *Journ. de Conch.*, p. 145, pl. 6, f. 2, 1886.

ADDENDUM.

A form of *Achatina* from North-east Rhodesia in the British Museum collection, has been kindly forwarded us by Mr. Edgar Smith for examination, and, if necessary, description, just in time to be included in this paper.

Of the size and general appearance of *A. morrelli* Preston, it differs in the obscurity of the decussate and spiral sculpture, one example, indeed, being almost completely smooth. The oblique dark brown zigzag flame-markings are more than usually regular and handsome. It may be varietally designated as follows:—

Achatina morrelli Preston.

var. *kafuensis* nov. (Fig. 8 of Plate).

Testa ut in typo, sed striis decussatis obscuris vel ferè evanidis, superficie nitida, plus minus lævigata, flammis fulgetrinis zebrinis regulariter eximiè et obliquè prædita.

Alt. 63. Diam. 30.

Hab. Chiwallas, Kafue River, N.E. Rhodesia (J. F. Quekett, Esq., in Mus. Brit.).

EXPLANATIONS OF THE PLATE.

1. *Lanistes neavei.*
2. *Cleopatra interizensis.*
3. *Lanistes neavei*, var. *unicolor.*
4. *Achatina rhodesiaca* (typ.).
5. „ „ var. *lanceolata.*
6. „ „ (typ.).
7. *Helicarion nyassanus*, Sm. var. *excellens.*
8. *Achatina morrelli*, Preston var. *kafuensis.*
9. „ *rhodesiaca*, var. *leucopasa.*

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Manchester Memoirs, Vol. li. (1907), *No.* 5.

V. On a Collection of Mammals made by Mr. S. A. Neave in Rhodesia, North of the Zambesi, with Field Notes by the Collector.

By R. C. Wroughton.

(*Communicated by Dr. W. E. Hoyle, F.R.S.E.*)

Received November 16th, 1906. Read January 29th, 1907.

The area in which Mr. Neave collected may be divided into two portions. The first, lying in the Valley of the Loangwa River, for the most part in the Basenga Country, on the East bank of that river. The forms found here are closely related to those found in Nyasa and Mashonaland—the more northern more closely to the former and the more southern to the latter. The second part of Mr. Neave's collecting ground lies East and West along the common boundary of Rhodesia and the Congo Free State, from the Mchinga Escarpment in the East to the new Rhodesian Station of Ndola on the Kafue River in the West.

It is amongst the forms from this area that those occur for which it has been found necessary to find new names in this paper. The general relationship of this fauna is undoubtedly with that of West, rather than of East Africa, but at the same time there seem to be quite a number of forms showing a curious resemblance to those found on the high plateau between Lakes Nyasa and Tanganyika.

Besides the specimens which have been examined and compared with those in the National Collection, there are a certain number which, on account of their bulk or for

other reasons, have not been brought to London, and, finally, also a certain number of forms (mostly well known) which were met with by Mr. Neave, but of which specimens were not brought home. These have been included in the list, on his authority, but are distinguished by their names being enclosed in brackets.

Cercopithecus pygerythrus.

Simia pygerythra, F. Cuvier, "Hist. Nat. Mamm.," vol. 24, 1821.

P. 6 ♂. E. bank of Loangwa. June 27, 1905. Alt. 1600.

P. 9 ♀. E. bank of Loangwa. Dec. 18, 1905. Alt. 1800.

"'Pusi' or 'Kolwe' of the Asenga.

"Common, especially in the Loangwa Valley."

[Papio cynocephalus (The Baboon)].

"'Kolwe' of most local tribes.

"Baboons are common throughout the country. They are very daring, and do considerable damage to native gardens."

Galago crassicaudatus.

Otolicnus crassicaudatus, E. Geoff., *Ann. Mus. d'Hist. Nat. Paris*, vol. 19, p. 166, 1812.

P. 4 ♀. Bank of Mezi. Sept. 26, 1904. Alt. 1600.

P. 7 ♂. E. bank of Loangwa. Aug. 9, 1905. Alt. 1800.

P. 8 ♀. Bank of Kafue. Oct. 21, 1905. Alt. 4000.

All these specimens are comparatively young and in their grey coat.

There is an unlabelled and mutilated skin, without

skull, which perhaps is the older stage of this or an allied form. The fulvous colouring of the dorsum, &c., is well marked, and the tail is black-tipped.

"A common species, especially in hilly country.

"'Changa' of all the local races."

Galago moholi.

Galago moholi, Smith. "Ill. Zool. S. Afr., Mamm.," 1839, pl. 8.

P. 1 ♂, P. 2 ♂, P. 3 ♂. N. bank of Mezi. Sept. 21, 1904. Alt. 1400.

P. 5 ♀. Petauke. Nov. 13, 1904. Alt. 2300.

The synonymy throughout this genus is in much confusion. Until this has been cleared up it is fruitless to distinguish geographical races. Smith's *moholi* was described from the Limpopo River.

"'Kamundi' of the Asenga, 'Kasimachali' of the Alala."

Rhinolophus æthiops.

Rhinolophus æthiops, Peters, *M. B. Akad. Wiss. Berl.*, 1868, p. 637.

C. 4, 5 ♀ ♀. Petauke, East Loangwa district. Jan. 24—26, 1905. Alt. 2400.

Dr. Andersen, who has been so kind as to examine these specimens, identifies them as *æthiops*. The species has hitherto only been recorded from Damaraland (type locality) and Angola. The present two specimens are in every respect indistinguishable from British Museum examples from Angola.

"The smaller bats are known to the Manganja and Lake tribes as 'Namsisi,' to the Asenga and Awembo as 'Kasuru.'

"There is also a species of *Rousettus* or an allied fruit-eating bat, of which I did not succeed in obtaining a specimen. This is known to the natives as 'Kamlima.'"

Nycteris capensis.

Nycteris capensis, Smith, *Zool. Journ.*, 1829, p. 433.
Nycteris fuliginosa, Peters, "Reis. Moss.," p. 46, 1852.

C. 1 ♂. Kapsuku Mountains, S. Rhodesia. Alt. 3400.

Dobson, in his Catalogue, lumps *fuliginosa* with *capensis*. When the genus comes to be worked out it is possible that these two forms will again be separated, in which case, judging from the locality of *fuliginosa* the present specimen will take that name.

Scotœcus hindei.

Scotœcus hindei, Thos., *Ann. Mag. Nat. Hist.*, (7), vol. 7, p. 264, 1901.

C. 2 ♂. Petauke, East Loangwa district. Nov. 14, 1904. Alt. 2400.

This is a most interesting specimen; for, though undoubtedly *S. hindei*, it possesses a very small but quite plainly visible anterior premolar not present in the type and hitherto only known specimen of *S. hindei*. This minute premolar is situated on the inner side of the tooth row, but not inside it, fitting into a notch in the inner side of the cingulum of the canine; this notch is clearly visible in the type of *hindei*, but there is no trace there of the minute premolar. Whether the presence or absence of this small tooth is the truly normal condition in *hindei* is a question which cannot be settled until more specimens are available for examination. It may be noted, however, that both tooth and notch are absent in the other two species (*albofuscus* and *hirundo*) of *Scotœcus*.

Pipistrellus nanus.

Vespertilio nanus, Peters, "Reis. Moss.," p. 63, 1852.

C. 6 ♂. Mterize River, Loangwa Valley. July 24, 1905. Alt. 1800.

Taphozous mauritianus.

Taphozous mauritianus, E. Geoff., "Descr. Egypte," vol. 2, p. 127, 1812.

Though it has a rather larger forearm, this specimen agrees well with specimens in the British Museum collection from British East Africa. It may be noted that this specimen has a forearm of 65 mm., while Dobson gives about 61 as normal.

Macroscelides brachyrhynchus.

Macroscelides brachyrhynchus, Smith, "Ill. Zool. S. Afr.," vol. 1, p. 13, 1838.

I. 1 ♀. Kapsuku Mountains, S. Rhodesia. May 24, 1904. Alt. 3400.

I. 6 ♀—7 ♂. Mseizi River, Feira district. July 19, 1904. Alt 1500.

I. 16 ♂. Niamadzi River, East Loangwa district. May 31, 1905. Alt. 2200.

I. 17 ♂. Mterize River July 17, 1905

I. 19 ♀. Ndola October 1, 1905. Alt. 4000.

I. 20 ♂. Msofu River, Alala Plateau. Nov. 7, 1905. Alt. 4000

The type was taken in the northern part of Bechuanaland, and the present specimens come from what must be the northern limit of the range of the species, which perhaps accounts for some small but not constant differences between them and typical *M. brachyrhynchus*.

"'Niakololo' of the Asenga."

Petrodromus tetradactylus.

Petrodromus tetradactylus, Peters, *Verh. Akad. Wiss. Berl.*, 1846, p. 258.

4 ♂, 5 ♀. Mseizi River. July 11 and 17, 1904. Alt. 1500.

8 ♀. Ntambwa's. Aug. 5, 1904. Alt. 1400.

12 ♀, 13 ♂. Petauke, East Loangwa district. Nov. 21, 1905. Alt. 2400.

14 ♂, 15 ♀. Mbala Country, May 12—13, 1905. Alt. 2000—2600.

These specimens seem quite normal. The type locality is in the Mozambique district of Portuguese East Africa. The British Museum Collection has specimens from Nyasa. These specimens extend the known range at least 10° westward.

"I found these elephant shrews very abundant.

"'Sakwi' of the Chikundo, 'Mtondo' of the Asenga."

Crocidura, sp.

I. 2 ♀. S. bank of Zambesi. June 21, 1904. Alt. 1400.

I. 3 ♀. S. bank of Zambesi. June 21, 1904. Alt. 1400.

I. 9 ♀. Near the Mezi River, Loangwa Valley. Sept. 1, 1904. Alt. 1500.

I. 10 ♀. East of Loangwa River. Sept. 10, 1904. Alt. 1500.

I. 11 ♀. N. bank of Mezi. Sept. 25, 1904 Alt. 1500.

I. 16 ♀. Mterize River. May 25, 1905. Alt. 1800.

I. 17 ♀. E. bank of Loangwa. June 7, 1905. Alt. 1600.

I. 17 ♀. E. bank of Loangwa. June 25, 1905. Alt 1600.

I. 18 ♀. Road to Chewalla's. Sept. 26, 1905. Alt. 4000.

The species in this genus have been multiplied to an enormous extent, more than 50 species of African Crocidura having been described. Peters has described three species from Tette, to any one of which, geographically, the present specimens might belong. Without comparison with the type, it would be rash to select one of the three

names, for none of the descriptions exactly fit; on the other hand, it would be folly to give a new name, and so risk further confusing the synonymy. The probability is that these specimens represent *hirta*, Peters.

"These small shrews are known to the Asenga as 'Susungira.' They have an extremely strong smell."

Crocidura neavei, sp. n.

I. 20 . Kafue River. Oct. 17, 1905. Alt. 4000.

A medium-sized, dark-coloured *Crocidura*. General colour a very dark brown as in *sylvia*, Thos. and Schw.; belly and all underparts only slightly paler. Ears rather large. Tail long, slender, dark, almost black, above and below (there is a distinct tuft of white hairs at the tip, below, but this may be an individual character), long hairs limited to the base as in *maurisca*, Thos.

Skull the same size as in *maurisca*, slightly shorter than in *sylvia*, but its greatest breadth as in the latter, markedly less than in the former, the intertemporal breadth greater and the skull markedly flatter (*i.e.*, shallower) than in either of these species. There are no marked peculiarities of dentition, but the upper tooth row behind the canine is slightly shorter than in either *maurisca* or *sylvia*. The maxillary width about as in *sylvia*, markedly greater than in *maurisca*, the anteorbital foramen twice as large as in either of the other species.

The following are the dimensions compared with those of *maurisca* and *sylvia*.

	neavei.	*maurisca*.	*sylvia*.
Head and body	80	75	81
Tail	60	60	53
Hind foot	16	14·4	15
Ear	9	?	8·5
Skull: Greatest length	20·5	21	22

	neavei.	*maurisca,*	*sylvia.*
Greatest breadth	9	9·5	9
Intertemporal breadth	5·6	5	5·3
Greatest depth	5	5·6	5·5

The long tail and hind feet and long-snouted flat skull, with huge anteorbital foramina, serve to distinguish this form from any other which I know.

[**Mellivora ratel** (The African Ratel)].

"'Chuuli,' of the Asenga.

"This animal appears to be fairly common throughout the country, though I did not succeed in obtaining a specimen. The natives are somewhat afraid of it, and have a quaint idea that if it hears a man mention its name, it will become very savage and impossible to kill. It is said to feed largely upon honey and insects of many kinds."

Ictonyx, sp.

Ca. 17 ♂. Fort Jameson. Jan. 15, 1906.

The specimen has neither label nor skull, and identification is impossible. It is probably *capensis*, Smith.

"A species which preys largely on mice and rats which it drives from their burrows by means of its stink glands.

"'Kashulira' of the Asenga and Alala, 'Kanyembe' of the Lake tribes."

Lutra, sp.

"'Katumbi' of the Asenga."

An otter of some species, probably *L. capensis*, occurs sparingly in the rivers. It is reported to be very abundant from near Lake Bangweolo.

[**Canis,** sp. (Jackal)].

"'Nkandwe' of most local tribes.

"Occurs sparingly throughout the country. I only saw one living specimen."

[**Lycaon pictus** (The Hunting Dog)].

"'Mmbulu' of the lake tribes, 'Pumpi' of the Asenga.

"This animal is fairly common throughout the country in packs of 4 or 5 to as many as 20 or 30 individuals. It is extraordinarily ferocious, and kills vast quantities of game. It is universally stated by natives to chase lions and will kill their cubs. I heard of no instance of its attacking man. I have witnessed a pack of these dogs hunting on the Loangwa, and they twice drove antelope into the river, one of which was immediately pulled under by crocodiles, the dogs themselves not entering the water at all. One old ♂ specimen was obtained."

[**Hyæna crocuta** (The Spotted Hyæna)].

"'Tika' of the Chikunda, 'Fisi' of the Lake tribes, 'Chimbwe' of the Asenga.

"The spotted Hyæna is common everywhere. It would usually appear to hunt singly. This cowardly animal becomes very daring on dark and stormy nights, and will steal articles from the middle of a camp. Natives sleeping outside occasionally are severely bitten by them."

1 ♂ skull.

Viverra civetta.

Viverra civetta, Schreber, "Saugth.," part 3, p. 418, 1778.

Neighbourhood of Petauke during 1905.

A flat skin labelled 32 without skull, and the skull of a quite young animal.

"'Mfungu' of the Asenga, 'Katumpa' of the Alala."

Genetta tigrina

Viverra tigrina, Schreber, "Saugth.," part 3, p. 425, 1778.

Ca. 3. N. bank of Mezi, Portuguese East Africa. Sept. 27, 1904. Alt. 1400.

Ca. 5. Mterize River. Nov. 5, 1904. Alt. 2000.

Ca. 8. Mbala Country. May 8, 1905. Alt. 2000.

The specimens undoubtedly belong to the *tigrina* group. Matschie in his monograph of the Genets separates from that species a form under the name of *mossambica*, which, geographically, is the nearest neighbour to the present specimens; he bases, however, on the width of the black rings of the tail and of the dorsal spots, both characters which are liable to vary with the "make up" of the specimen. Messrs. Thomas & Schwann in a list of mammals collected in the Zoutpansberg District of the Transvaal in connection with the "Rudd Exploration," describe a form closely allied to *tigrina* under the name of *letabæ*.* This form is said to have the tail longer than the head and body, otherwise it agrees fairly closely with the present specimens. Under the circumstances I think it safer to place these specimens for the present, at any rate, under the group name *tigrina*.

"Very common throughout the country.

"'Cimba' of the lake tribes and the Asenga, 'Nshimta' of the Alala."

Mungos cafer.

Viverra cafra, Gmelin, Linn., "Syst. Nat.," vol. 1, p. 85, 1789.

Ca. 15 ♀. Near Kapopo. Oct. 26, 1905. Alt. 4000.

"A somewhat scarce species, though widely distributed according to native accounts.

"'Nenga' of the Asenga, 'Chisakanenga' of the Alamba."

Mungos gracilis.

Herpestes gracilis, Rüpp, "N. Wirb. Abyss.," p. 29, 1835.

Ca. 7. Lichunio, near Petauke. April 11, 1905. Alt. 2000.

Ca. 10. Mterize River, Loangwa district. July 25, 1905. Alt. 1800.

* *P.Z.S.*, 1906, p. 578.

Unfortunately, labels are missing from both specimens, but there are two skulls labelled as above which clearly belong to them, but which to which cannot be decided absolutely. Of the two specimens, one with rather coarser grizzling and a bright rufous tinge on the face and crown closely resembles a specimen in the British Museum collection from Zomba, British Central Africa, and the skull, too, corresponds very closely with Ca. 7 (above), allowing for the younger state of the latter which still has its milk canines unshed. The other specimen has the face and crown tinged with black, and closely resembles a specimen in the collection obtained by Mr. Boyd Alexander on the "Right bank of the Zambesi." The skull of this specimen, however, does not correspond well with Ca. 10, which for its size (it is very slightly larger than Ca. 7, and also slightly older, the milk canines having been recently shed) is broader, especially between the bullæ and the canines, and stouter, and has larger bullæ than any specimen I have seen. However, in view of the doubt in the allotment of the skulls, I think the safest course is to identify them merely as *M. gracilis*, to which group both specimens undoubtedly belong.

"'Likongwe' of the Lake tribes and the Asenga"

Mungos, sp.

The specimen is a flat skin, with the feet missing; the label gives the date November 20, 1905, but no locality or serial number, and there is no skull. Identification is impossible beyond that it is a member of the *albicauda* group.

"A native skin obtained at Chiwali's on the Alala Plateau. It had been killed the previous day.

"'Nyanga' of the Alala."

Helogale undulata.

Herpestes undulatus, Peters, "Reis. Moss.," p. 114, 1852.

Ca. 2 ♂. N. bank of Mezi. Sept. 24, 1904. Alt. 1400.

Ca. 4 ♀. N. bank of Mezi. Sept. 28, 1904. Alt. 1400.

Ca. 6 ♀ (yg.). Lichunio, near Petauke. April 11, 1905. Alt. 2000.

The locality of the type is given by Peters as Mozambique, 10°—15° S. Lat.

"'Lisicherere' of the Asenga. This small species is usually in colonies."

Helogale varia.

Helogale varia, Thos, *P.Z.S.*, 1902, p. 119.

Ca. 16 ♀. Msofu River, Alala Plateau. Nov. 7, 1905. Alt. 4000.

The locality of the type is Mweru-Nyasa.

Rhynchogale melleri.

Rhinogale melleri, Gray, *P.Z.S.*, 1864, p. 575.

Ca. 12 ♀. Near Msanzara River, Loangwa Valley. Aug. 7, 1905. (No skull.)

"'Umbi' of the Asenga. Not uncommon, but very hard to obtain specimens of. This specimen killed by a native and the skull unfortunately destroyed."

Crossarchus fasciatus.

Crossarchus fasciatus, Desm., "Dict. Sci. Nat.," vol. 29, p. 58, 1823.

Ca. 1 ♂ (yg.). N. bank of Zambesi, near Feira. June 17, 1904. Alt. 1400.

Ca. 11 ♂ (yg.). Mterize Country. July 27, 1905. Alt. 1800.

Ca. 13 ♀. Bank of Kafue. Oct. 21, 1905. Alt. 4000.

Ca. 14 ♂. Near Kapopo. Oct. 26, 1905. Alt. 4000.

"A very common species, sometimes in colonies.

"'Chipulwe' of most of the local tribes."

[**Felis leo** (The Lion)].

"'Mkango' of the Lake tribes, 'Pandoro' of the Chikunda, 'Nkalamo' of the Asenga.

"Lions are common throughout the country but are seldom seen, especially in the more wooded districts.

"The food of lions appears by no means to consist entirely of large mammals, as they will kill and eat porcupines, cane-rats, etc. I have even had fruits pointed out to me which it was stated formed the food of lions in times of scarcity."

2 ♀ ♀.

[**Felis pardus** (The Leopard)].

"'Nyalugwe' of the Lake tribe, 'Kaiengo' of the Asenga, 'Mbalale' of the Alala.

"Common throughout the country. The leopard seems to prey largely upon smaller carnivores, and I have several times come across specimens of *F. serval* killed by them. It is also remarkably fond of dogs. Cane-rats too are killed in large numbers by them."

2 ♂ ♂.

Felis ocreata.

Felis ocreata, Gmelin, "Anh. Bruce Reis.," p. 27, 1791.

Two flat skins, each labelled (34), without skulls, from the neighbourhood of Petauke, Sept.—Nov., 1905.

"Two native skins. These cats are common, but seldom seen.

"'Madzampaka' of the Asenga."

Felis serval.

Felis serval, Erxl., "Syst. Regn. Anim.," p. 523, 1777.

Ca. 9 ♀. Mterize River. July 16, 1905.

The skull unfortunately is missing, but the skin seems to be a quite normal one.

"'Njuzi' of the Chikunda, 'Mbale' of the Asenga"

[**Felis caracal** (The Caracal)].

"I saw one skin of this species which had been obtained in the Northern part of the territory."

Cynælurus jubatus.

Felis jubata, Erxl., "Syst. Reg. Anim.," p. 510, 1777.

(12) sex? Southern Mbala Country. May or June, 1904.

The mane is very strongly marked in this specimen, but Col. Bingham tells me that some years ago he saw a living individual of this species in captivity at Aden, which had been taken in the Somali Country, and which had a mane 4 inches long; this is not, therefore, a specially local character.

A native skin.

"Cheetahs appear to be exceedingly rare in the country.

"'Kambulumbulu' of the Asenga."

Anomalurus cinereus.

Anomalurus cinereus, Thos., *Ann. Mag. Nat. Hist.*, (6), vol. 15, p. 188, 1895.

R. 140 ♀, 141 ♀. Ndola. Oct. 5—7, 1905. Alt. 4000.

"The only two specimens met with. This species appears to be nocturnal in its habits, and to conceal itself in hollow trees by day.

"'Mpepi' of the Alamba. It is also known by the same name on the Angoni Plateau"

Sciurus mutabilis.

Sciurus mutabilis, Peters, *M.B. Akad. Wiss. Berl*, 1852, p. 273.

R. 74 ♀. Petauke. March 13, 1905. Alt. 2400.

R. 82 ♀, 83 ♂. Petauke. March 30, 1905. Alt. 2400.

R. 132 ♀. Mterize River. July 26, 1905.

R. 127. Mterize River. July 19, 1905.

R. 131. Mterize River. August 25, 1905.

Native skins, Mterize River, May, 1905.

Two flat skins. This series proves how well this species deserved the name *mutabilis*.

"I had quite made up my mind that this series represented two species.

"I found the reddish forms are common and widely spread, and are called 'Kasiri.'

"The dark forms I only obtained from the Mterize River, where they are called 'Kaiaiye' by the natives.

"I never saw either form away from the dense jungle on the banks of streams."

Funisciurus annulatus rhodesiæ, sub. sp. n.

R. 137 ♀. Road to Chewalla's. Sept. 27, 1905. Alt. 4000.

R. 145 ♂, 146 ♀ (yg.). Road to Chewalla's. Nov. 14, 1905. Alt. 4000.

Desmarest in his description of *annulatus* gives the colour as "gris-verdâtre clair, provenant de ce que les poils y sont gris à la base et terminés de jaunâtre." He gives no type locality, but a West African squirrel exactly answers his description and has been accepted as *annulatus*. The British Museum possesses specimens of this species from Gambia, Angola, &c. The coloration in the series is very constant, the more northern specimens being on the whole more brightly coloured. The present specimens, while agreeing fully in the general pattern of coloration, can be picked out of the series at a glance, owing to the complete absence of the yellow tinge so characteristic of typical *annulatus*. The hairs of the back are about 15 mm. in length; black for the basal third,

then with a yellowish white ring not quite so broad, the terminal third being black interrupted by a narrow (2—3 mm.) white ring, the general effect being a pale grizzled grey. The cheeks, which in typical *annulatus* are pale buff, are here white, and the streaks above and below the eye are in these specimens a bright silvery white and most conspicuous. The feet also differ from those of *annulatus* in wanting the yellow (or buff) tinge.

The skull is rather larger in all dimensions than that of *annulatus*, the bullæ especially are markedly larger; but the length of the upper molar series is the same in both forms.

Properly measured specimens of *annulatus* of the same age as this adult specimen are not available, but one somewhat younger from Gambia is described by the Collector as head and body 190, tail 210, hind feet 48, ear 16.

The following are dimensions:—

	137 ♀ (type).
Head and body	213
Tail	219
Hind foot	41·5 (?46·5).
Ear	16
Skull: Greatest length	48
Basilar length	36
Zygomatic breadth	27
Interorbital breadth...	14
Length of upper molar series ...	9
Length of bullæ	11
Age	Adult.

The tail of this specimen has apparently been damaged during life.

"This species would appear to be confined to the High Plateau country, west of the Mchinga Escarpment. It is

not known to natives of the Loangwa Valley. The Alala call it 'Kapali,' the Alamba 'Lupali,' and the Awisa 'Kwikwi.'"

Funisciurus cepapi.

Sciurus cepapi, Smith, "Rep. Exp. Expl. C. Afr.," p. 43, 1836.

R. 86 ♂. Lichunio, near Petauke. April 6, 1905. Alt. 2,200.

R. 88 ♂. Lichunio, near Petauke. April 10, 1905. Alt. 2,200.

R. 108 ♂. Ulungu Mountain. June 11, 1905. Alt. 3000.

R. 113 ♂. Ulungu Mountain. June 13, 1905. Alt. 3000.

R. 116 ♀. E. bank of Loangwa. June 18, 1905. Alt. 2200.

The last two of the above series are brighter than the co-type of *cepapi*, which is in the British Museum collection, and are quite like a specimen sent by Sir H. Johnston from Monkey Bay, on Lake Nyasa; while the first three on the other hand are much duller coloured. That they all are *cepapi*, however, there seems to be no doubt.

"This species is seldom met with except on 'Mopani' flats, near the larger rivers. 'Gologolo' of the Manganja and Lake tribes, 'Kasidye' of the Asenga."

Graphiurus murinus.

Myoxus murinus, Desm., "Mamm.," Suppl., p. 542, 1822.

R. 91 ♀. Petauke. April 25, 1905. Alt. 2400.

R. 92 ♀. Mbala Country. April 28, 1905. Alt. 2600.

R. 94 ♀. Mbala Country. May 2, 1905. Alt. 2600.

"'Kasulamo' of the Asenga."

Graphiurus nanus.

Myoxus (*Eliomys*) *nanus*., de Wint., *P.Z.S.*, p. 799, 1896.

R. 15 ♀. Mseize River. July 18, 1904. Alt. 1500.

R. 40 ♀, Petauke. Nov. 18, 1904. Alt. 2400.

R. 60, 61 ♀ ♀. Petauke. Feb. 10, 1905. Alt. 2400.

R. 133 ♀. E. bank of Loangwa. August 11, 1905. Alt. 1600.

R. 147. Petauke. Dec. 12, 1905. Alt. 2400.

"Not distinguished by natives from the last species."

Tatera lobengulæ mashonæ.

Tatera lobengulæ mashonæ, Wrought., *Ann. Mag. Nat. Hist.*, (7), vol. 17, p. 476, 1906.

R. 2, 5 ♂. S. bank of Zambesi. May 28, 1904. Alt. 1250.

R. 1 ♂. No skin. Feira-Zambesi. May 26, 1904. Alt. 1250.

R. 25 ♂. East of Loangwa. Portuguese East Africa. Sept. 10, 1904. Alt. 1400.

R. 41, 51 ♂, 71 ♀. Petauke. Nov. 18 and 19, 1904, and March 9, 1904. Alt. 2400.

"'Mpundu' of the Asenga."

Tatera panja.

Tatera panja, Wrought., *Ann. Mag. Nat. Hist.*, (7), vol. 17, p. 476, 1906.

R. 3 ♀. S. bank of Zambesi. May 27, 1904. Alt. 1250.

Tatera neavei, sp. n.

R. 128, 139 ♀ ♀. Ndola. October 2, 1905. Alt. about 4000.

A rather small *Tatera*, much resembling *nigrita* in general appearance, but having a marked pale (albescent) streak on the face, above and below, from about the middle of the eye extending to the ear; this streak, however, is broken by a blackish patch just below the base of the ear. The skull dimensions are also as in *nigrita*, but so far as the material available shows, the interparietal is

longer and much more convex posteriorly, giving a posteriorly tapering look to the skull when viewed from above. The grooves of the incisors are obsolescent.

The following are measurements of these two specimens and of the type of *nigrita*.

	R. 138 (type).	R. 139.	*nigrita* ♀.
Head and body	130	124 (?134)	135
Tail	127	132·5	140
Hind feet	33·5	34	32
Ear	20	22	20
Greatest length of skull ...	38	?	38
Basilar „ „ ...	29	?	30
Zygomatic breadth	20	?	20
Length of upper molar row ...	6	6	6
Ant. post. : length of bullæ ...	10·5	?	11

All these specimens are fully adult.

In my review of the Genus *Tatera*,* I pointed out that short-tailed forms were characteristic of the country between the Zambesi and the Equator. In this character *neavei* supports my view, but instead of resembling *nyasæ* or *nyasæ shirensis*, its near neighbours, it must in my key (l.c, p. 477) be placed at the end of the first group of Section II. under c. with the Uganda form *nigrita*. From that species it may be distinguished exteriorly by the face marking, by the comparatively shorter tail and larger hind feet. In skull characters the most distinctive is the obsolescence of the grooves of the incisors, as in *fallax*, which suffices to distinguish it from any *Tatera* of its size.

"The note in my diary on this species says 'Perhaps a variety of "Mpundu," but a much less red skin. Typical "Mpundu" also occur here.'"

* *Ann. Mag. Nat. Hist.*, (7), vol. 17, p. 474, 1906.

Gerbilliscus boehmi.

Gerbillus boehmi, Noack, *Zool. Jahrb.*, vol. 2, p. 241. 1888.

R 101 ♀. Mbala Country. May 7, 1905. Alt. 2600.

R 104. Mbala Country. May 13, 1905. Alt. 2600.

The type came from Tanganyika and was distinctly smaller, in all dimensions, than these specimens, but there is a specimen from the Nyika Plateau, British Central Africa, which is almost as large.

"I had heard of the existence of this species long before I succeeded in obtaining specimens. It prefers somewhat open sandy country, living in burrows. It is exceedingly active. The Asenga call it 'Mtoroka' and state that adult males are *much* larger than either of the above specimens."

Dendromus pumilio.

Dendromys pumilio, Wagn., *Münch. Gel. Anz.*, vol. 12, p. 437, 1820.

R 21 ♂. Pakolwe Mountain. August 20, 1904.

R 26, 30 ♂, 29 ♀. Portuguese East Africa. Sept. 10—12, 1904.

R 34 ♂. Mterize River. Oct. 31, 1904.

These specimens are quite the same in all essential characters as a series from Nyasa in the British Museum Collection. No species have been described from this part of Africa and the material available for examination is rather meagre. It seems to me best to refer these specimens, at any rate for the present, to one of the two South African species. Skulls which have been identified as *mesomelas* Brants are consistently distinguishable by the shape of the frontals from the present specimens which I therefore call provisionally *pumilio*.

"This small species is said to be especially common in Banana plantations. 'Msuntwa' of the Lake tribes as well as of the Asenga."

Steatomys pratensis.

Steatomys pratensis, Peters, *S.B. Akad. Wiss. Berl.*, 1846, p. 258.

Steatomys edulis, Peters, "Reis. Moss.," p. 163, 1852.

R. 13 ♀, 14 ♂. N. bank of Zambesi. July 16, 1904. Alt. 1500.

R. 52, 53 ♀ ♀. Petauke. Dec. 24, 1904. Alt. 2400.

R. 56 ♂, 57 ♀. Petauke. Dec. 29, 1904. Alt. 2400.

R. 87 ♂. Lichunio, near Petauke. April 7, 1905.

"This species, which is very common, is called 'Ngambwa' by the Asenga. I was much struck by the fact that a large number of the individuals I saw, were *blind* in one or both eyes.

"When I was in the Mbala Country on May 4, 1905, six specimens of this mouse were dug out of a burrow in the middle of my camp. Of these two were blind in both eyes and two others in one eye.

"All mice and rats are eaten by the natives, but this is considered a special delicacy on account of its fat."

Mus rattus.

Mus rattus, Linn., "Syst. Nat.," ed. x., p. 61, 1758.

R. 18 ♂. Ntambwa's. August 3, 1904. Alt. 1400.

R. 19 ♀. Ntambwa's. August 5, 1904. Alt. 1400.

R. 49 ♂. Petauke. December 17, 1904. Alt. 2400.

? ♀. ? ? ?

These are not unlike specimens of *rattus* from the Nyika Plateau, British Central Africa, but there is less brown in the colouring, and the skull is somewhat shorter and wider.

"'Koswe' of all local tribes. It is a great pest in many native villages."

Mus walambæ, sp. nov.

R. 135 ♀. On the Plateau. September 12, 1905. Alt. 4000.

R. 142 ♂. Kafue River. Oct. 19, 1905. Alt. 4000.
R. 143 ♂. Msofu River. Nov. 8, 1905.

A medium sized rat with the outward characters and proportions very much as in *hindei*, Thos. from British East Africa. Fur soft and glossy; hairs of back about 10 mm. in length. General colour bright tawny, dulled by the dark slate almost black bases of the hairs showing through; paler on the sides. Cheeks, throat and belly dull white (the hairs with slatey bases), the last not sharply defined from the upper side. Tail short, above brown, darkening distally to almost black, below dull white also darkening towards the tip.

The skull characters on the whole as in *hindei* but the anteorbital plate, though "not concave below" as in *hindei*, shows a distinct angle where the upper and anterior edges meet as in *nyikæ*. The palate, however, does not extend backwards as in *hindei*, not even so much so as in *nyikæ*; both molars and bullæ larger than in either *hindei* or *nyikæ*.

The dimensions are as follows.

	R.135	R.142 (*Type*).	R.143	*hindei*. —	*nyikæ*. —
Head and body	150	147·5	155	179 (?)	157
Tail.....	124·5	120	128	124	151
Hindfoot	25·5	26	25	27·3	27
Ear.....	21·5	20	20	19	18
Skull: greatest length...	37	37	37	38	35·5
Basilar length	32	31·5	32	30	?
Zygomatic breadth	20	20	21	19·7	19
L. of upper molar series...	7	7	7	5·9	6·7
Ant. post length of bullæ	8	8	8	7	6·5
Age and Sex...	adult ♀	old ♂	old ♂	adult ♀	

Though geographically *nyikæ* intervenes, *walambæ* certainly more nearly resembles *hindei*, the brighter colouring and larger molars and bullæ serve to distinguish

it. From *nyikæ* as from its other neighbour *chrysophilus* its short tail at once separates it, and its broader skull and much larger bullæ serve to further distinguish it from *nyikæ*.

"'Mtuku' of the local natives. Inhabits swampy grass country and is seldom trapped."

Mus sp. (multimammate).

R. 4 ♀ (yg.). S. bank of Zambesi. May 27, 1904. Alt. 1250.

R. 12 ♀ (yg.). North of Zambesi. July 14, 1904. Alt. 1500. (No skull).

R. 20 ♂. Ntambwa's. Aug. 6, 1904. Alt. 1400.

R. 22 ♂. Portuguese East Africa. Aug. 26, 1904. Alt. 1400.

R. 72 ♂ (yg.), 73 ♀. Petauke. March 13, 1905. Alt. 2400.

R. 80 ♀. Petauke. March 29, 1905. Alt. 2400.

(R 99 ♂?). Mbala Country. May 6, 1905. Alt. 2600.

? ♂. ? ? ?

Mr. Thomas, writing (*P. Z. S.*, 1897, p. 936) on some rats similar to these from Nyasa, spoke of them as "belonging to the groups characterized respectively by "their numerous mammæ (multimammate) and by having "the mammary formula 3 – 2 = 10. It is impossible to "work them out more definitely at present." No one has yet so far as I know, tackled this problem. The present specimens seem to belong to a form having 8 pair of mammæ.

"'Mtika" of all the local tribes. This species swarms all over the country. I have trapped as many as 80 specimens in a single night."

Thamnomys dolichurus.

Mus dolichurus, Smuts, "Enum. Mamm. Cap.," p. 38, 1832

Mus arborarius, Peters, "Reis. Moss.," p. 152, 1852.

R. 36 ♀. Petauke. Nov. 13, 1904. Alt. 2300.

R. 46 ♀. Petauke. Dec. 12, 1904. Alt. 2400.

R. 62 ♂. Petauke. Feb. 12, 1905. Alt. 2400 (no skull).

R. 76 ♀. Petauke. March 21, 1905. Alt. 2400.

R. 84 ♀. Petauke. April 3, 1905. Alt. 2400.

R. 93. Mbala Country. May 2, 1905. Alt. 2600.

R. 117. E. bank of Loangwa. Portuguese East Africa. June 23, 1905. Alt. 2000.

R. 119 ♂. E. bank of Loangwa. Portuguese East Africa. June 27, 1905. Alt. 2200.

R. 120 ♀. E. bank of Loangwa. Portuguese East Africa. July 4, 1905. Alt. 2200.

R. 123 ♀. E. bank of Loangwa. Portuguese East Africa. July 6, 1905. Alt. 2200.

R. 148 ♀. Petauke. Dec. 29, 1905. Alt. 2400.

These specimens have longer tails (both absolutely and proportionately to the body) than Peters' *arborarius*. Specimens from Ruwenzori recently received by the British Museum have tails as long, but the body also is slightly longer.

Smuts' *dolichurus* from the Cape is said to have a black mark before and under the eye, and a golden tinge on the belly (I cannot detect either of these characters in Smuts' plate), and Peters relies on these characters to distinguish *dolichurus* from his *arborarius*. Sundevall's *pendulus* is said to have a much shorter tail. None of these types is available for examination by me. Mr. Thomas has used *dolichurus* for Nyasa specimens, so, at any rate for the present, these specimens must rank as *dolichurus*.

"This species is known to the Asenga as 'Sakasse.'"

Mus, sp.

R 59 ♀. Petauke. Jan. 27, 1905. Alt. 2400.

R 103 ♂. Mbala Country. May 9, 1905. Alt. 2600.

R 105 ♀. Mbala Country. May 17, 1905. Alt. 2600.

R 121 ♀. E. bank of Loangwa. July 4, 1905. Alt. 2200.

These specimens represent more than one form but in such a difficult group and with so little material I hesitate to give them names.

Mus chrysophilus.

Mus chrysophilus, de Wint, *P.Z.S.*, 1896, p. 801.

R 8 ♀ (yg.). S. bank of Zambesi. June 21, 1904. Alt. 1400.

R 48 ♂ (yg.). Petauke. Dec. 14, 1904. Alt. 2400.

R 66 ♂. Petauke. Feb. 23, 1905. Alt. 2400.

R 97 ♂. Metambadzi River. May 4, 1905. Alt. 2600.

R 102 ♂. Mbala Country. May 8, 1905. Alt. 2600.

R 109 ♀. Ulungu Mountain. June 12, 1905. Alt. 3000.

R 111 ♀, 112 ♀. Ulungu Mountain. June 13, 1905. Alt. 3000.

R 118 ♀. E. bank of Loangwa. June 27, 1905. Alt. 2,200.

The type locality is Mashonaland.

Saccostomus campestris.

Saccostomus campestris, Peters, *M.B. Akad. Wiss. Berl.*, 1846, p. 258.

Saccostomus lapidarius, Peters, " Reis. Moss.," p. 167, 1852.

R. 9 ♂. Sixty miles west from Feira. June 25, 1904. Alt. 1400.

R. 16 ♀. Mseize River. July 19, 1904. Alt. 1500.

R. 45 ♀. Petauke. December 11, 1904. Alt. 2400.

R. 50 ♂, 57 ♀. Petauke. December 18, 29, 1904. Alt. 2400.

R. 67 ♀. Petauke. Feb. 24, 1905. Alt. 2400.

R. 69 ♀. Petauke. March 2, 1905. Alt. 2400.

R. 96 ♀. Mbala Country. May 2, 1905. Alt. 2600.

R. 106 ♂. Mterize River. May 23, 1905. Alt. 2400.

"'Fundwe' of the Asenga. A common species."

Acomys selousi.

Acomys selousi, de Wint., *P. Z. S.*, 1896, p. 807.

R. 38 ♂, 43 ♀. Petauke. Nov. 16, 30, 1904. Alt. 2400.

R. 58 ♂. Petauke. Jan. 26, 1905.

R. 65 ♂. Petauke. Nov. 20, 1905.

R. 107 ♀. Miamadzi River. June 2, 1905.

R. 110 ♀. Ulungu Mountain. June 13, 1905.

(?) R. 128 ♀, 129 ♀. Mterize Country. July 24, 1905.

These specimens agree well with a series in the National Collection from the Nyika Plateau, British Central Africa. They resemble *selousi* from Matabeleland, but have the tail shorter than the head and body, while in *selousi* it is longer. Without spirit specimens I do not venture to separate this form from *selousi*.

"A rather local species. I never met with it near the Zambesi or in the Feira district. It is a very difficult species to obtain good specimens of, owing to its fragile skin. The Asenga call it 'Mphula.'"

Leggada musculoïdes.

Leggada musculoïdes, Temm., "Esq. Zool. Guinée," p. 161, 1853.

R. 10 ♂. Mseizi River. July 13, 1904.

R. 55 ♂. Petauke. Dec. 28, 1904.

R. 81 ♀. Petauke. March 30, 1905.

"Both this and the next species are called 'Niamgolwa' by the Asenga. They are not very common, but

are very destructive in one's tent on account of their habit of gnawing clothes."

Leggada minutoïdes.

Leggada minutoïdes, Sm., *S.A.Q. Journ.*, vol. 2, p. 167, 1835.

R. 23 ♀. Portuguese East Africa. August 26, 1904.

R. 37 ♂. Petauke. Nov. 14, 1904.

? ? ?

Arvicanthis dorsalis.

Mus dorsalis, Smith, "Ill. Zool. S. Africa," pl, 46, 1849.

R. 7 ♀. S. bank of Zambesi. June 21, 1904. Alt. 1400.

R. 17 ♀. N. bank of Zambesi. July 19, 1904. Alt. 1500.

R. 28 ♂. E. bank of Loangwa, Portuguese East Africa. Sept. 11, 1904. Alt. 1400.

R. 39 ♀. Petauke. Nov. 16, 1904. Alt. 2400.

R. 42 ♂. Petauke. Nov. 22, 1904. Alt. 2400.

R. 54 ♂. Petauke. Dec. 26, 1904. Alt. 2400.

R. 89 ♂. Lichunio, near Petauke. April 12, 1905. Alt. 2200.

R. 100 ♀. Mbala Country. May 6, 1905. Alt. 2600.

R. 107 ♂. E. bank of Loangwa. June 6, 1905. Alt. 2200.

R. 115 ♂. Ulungu Mountain. June 15, 1905. Alt. 3000.

R. 134 ♂. E. bank of Loangwa. Aug. 14, 1905.

Smith's type had a tail equal in length to the head and body, and a co-type in the British Museum Collection indicates the same proportion. Specimens from Mashonaland also show this proportion, while those from Zululand, N.W. Transvaal, &c., have a tail considerably longer than the head and body, as have the present specimens.

"A common species. It is called 'Yendakadzua' by the natives, which means 'he that walks in the Sun.'"

Pelomys fallax.

Pelomys fallax, Peters, "Reis. Moss," p. 157, 1852.

R. 24 ♂. E. bank of Loangwa. September 3, 1904. Alt. 1400. (Skull missing).

R. 27 ♀. E. bank of Loangwa, Portuguese East Africa. September 11, 1904. Alt. 1400.

R. 78 ♀. Petauke. March 23, 1905. Alt. 2400.

R. 125 ♀. E. bank of Loangwa. July 9, 1905. Alt. 2200.

The type locality is Boror in Mozambique.

"A somewhat uncommon species, called 'Mendi' by the Asenga."

Georychus amatus, sp. n.

R. 144 ♂. Road to Chiwali's, Alala Plateau. Nov. 13, 1905. Alt. 4000.

Rather smaller than *darlingi*, Thos., from Mashonaland, which is its nearest neighbour. Fur and colour as in *darlingi*, *i.e.*, fawn, much modified by the dark slate-coloured bases of the hairs which show through (at any rate in a made up skin). The white frontal patch so consistently characteristic of *darlingi* is, however, entirely absent. A white patch from the corner of the mouth extending backwards to a line drawn vertically through the ear, and downwards on to the chin and throat This patch I find present in some quite young specimens of *darlingi* and indicated in some older ones, but I have found it in no other species which I have seen. Though the premaxillary processes and anteorbital foramina are shaped much as in *darlingi*, the skull is distinctly lighter and narrower with much smaller bullæ.

The following are dimensions as compared with *darlingi* (type), the latter is a much younger specimen than the present one, otherwise I believe the skull differences would have been greater.

	144 ♂ (type)	*darlingi* (type).
Head and body ...	105	128
Tail	10	12
Hind foot	20	22
Skull: Basilar length ...	27·5	26·2
Nasals	11 × 3·3	10·8 × 3·1
Interorbital breadth ...	10	10
Zygomatic breadth ...	22	22·6
Intertemporal breadth...	6	7
Supra auricular breadth	13	14·1
Palate from henselion ...	19·3	19·3
Diastema	10·5	10·1
Upper Molar row length	5·1	5·7
Base of incisors breadth ...	4·8	4·6
Bullæ, ext. post: to int-ant. diameter...	7·5	9

"The only specimen met with, but said by natives to be commonly captured on the High Plateau country in the rainy season.

"This species does not appear to inhabit the Loangwa Valley.

"It is called 'Kakoko' by the Alala and Awisa."

Heliophobius argenteo-cinereus.

Heliophobius argenteo-cinereus, Peters, "Reis. Moss.," p. 140, 1852.

R. 35 ♀. Mterize River. Nov. 4, 1904. Alt. 2000.
R. 44 ♀ (yg.). Petauke. Dec. 9, 1904. Alt. 2400.
R. 47 ♀ (yg.). Petauke. Dec. 12, 1904. Alt. 2400.
R. 75 ♂ (yg.). Petauke. Dec. 14, 1905. Alt. 2400.
R. 79 ♀ (yg.). Petauke. March 24, 1905. Alt. 2400.
R. 85 ♂, Petauke. April 3, 1905. Alt. 2400.
R. 95 ♂. Mbala Country. May 2, 1905. Alt. 2400.
R. 98 ♀. Mbala Country. May 5, 1905. Alt. 2600.

The type locality is Tette. In skull characters these specimens differ a little from Peter's plate of *argenteo-cinereus*, especially in having the postorbital processes more marked, and in this they approach *robustus*, Thos., from the Mpika Plateau. These differences, however, are insufficient to justify their separation from *argenteo-cinereus*.

"Common everywhere, but hard to obtain except during the rains.

"'Mppuko' of all local tribes."

Lepus whytei.

Lepus whytei, Thos., *P.Z.S.*, 1894, p. 142.

R. 64 ♀. Petauke, East Loangwa District. Feb. 14, 1905. Alt. 2400.

R. 90 ♂ (yg.). Lichunio, near Petauke. April 14, 1905. Alt. 2200.

R. 124 ♀ (yg.) E. bank of Loangwa. July 7, 1905. Alt. 2200.

The skull is larger than in typical *whytei*, but the colouring and essential skull characters distinguish it as undoubted *whytei*.

"These hares are distinctly scarce.

"'Kalulu' of all the tribes in this part of Africa. For some reason, which it is not easy to see, the hare is considered by natives to be an exceedingly cunning animal, and figures as such in all their folk-lore."

Thryonomys swinderenianus.

Aulacodus swinderenianus, Temm., "Mon. Mamm.," vol. 1, p. 245, 1827.

R. 31, 32. Mezi River. September 26, 1904. Alt. 1400.

R. 33 ♂. N. bank of Mezi. October 4, 1904. Alt. 1400.

R. 122 ♂. E. bank of Loangwa. July 5, 1905. Alt. 2200.

There are two skins without labels which belong probably to R. 31 and 32 above, while the skull of R. 33 is missing.

"'Gunguzi' of the Achawa, 'Nchenzi' of the other Lake tribes and the Asenga, 'Nsenzi' of the Alala, Awisa and Awemba.

"These cane-rats, which are common in suitable localities are excellent eating, as I can testify from personal experience."

Hystrix africæ-australis.

Hystrix africæ-australis, Peters, "Reis. Moss.," p. 170, 1852.

R. 130 (yg.) ♀. Mterize Country. July 25, 1905.

R. ?. Near Petauke. June, 1905. (No skin.)

"'Nungu' of the Manganja and Lake tribes, 'Nunji' of the Asenga.

"Porcupines are exceedingly common all over the country, but are seldom seen owing to their nocturnal habits."

[**Procavia**, sp.].

"Dassies were reported by natives to occur on the rocky sides of hills in one or two places, but I did not succeed in obtaining any specimens.

"'Mbira' of the Nyasa tribes."

[**Elephas africanus** (The African Elephant)].

"'Njobvu' of the Lake tribes, 'Njovu' of the Asenga, 'Nzobvu' of the Alala and Alamba.

"Still common in the country and reported abundant from the more northern districts. Large specimens are now rare in the Loangwa valley. With the present efficient protection the elephant should increase in this part of Africa."

One ♂ immature.

[**Rhinoceros bicornis.**]

"'Chipembere' of most native races, 'Ukoli' of the Alamba.

"The Rhinoceros is by no means uncommon in the Loangwa valley, but is not very often seen."

[**Equus burchelli** (Burchell's Zebra)].

"'Mbidzi' of the Lake tribes, 'Mbwete' of the Asenga.

"Zebras are enormously abundant nearly all over the country, not having suffered from the rinderpest of some years ago. They prefer hilly country, and can travel with ease over remarkably steep slopes. Solitary stallions, which have been turned out of the herd, are not infrequently met with amongst herds of other game, especially Mpala or Haartebeeste. I have even seen them with pig."

1 ♂.

Potamochœrus chœropotamus.

Sus Koiropotamus, Desmoul., "Dict. Class. Hist. Nat.," vol. 17, p. 139, 1831.

A quite young individual.

"Bush pigs are common, and do a considerable amount of damage to native gardens. It is perhaps more local than the Warthog, and, inhabiting denser bush, is seldom seen. The sow gives birth to 5 or 6 young at a time. The young are striped. 'Nguluwe' of most local tribes."

1 ♀ skull, ad.

[**Phacochœrus? africanus.**]

'Njiri' of most of the local tribes.

"Common all over the country. Generally solitary or in pairs, occasionally an old sow and her family may be met with. Three at a birth seems to be the almost invariable

number for this species, the young being black like the parents. The Warthog has a very curious habit of kneeling down on its forelegs when digging in the ground for roots, etc."

1 ♀.

[Hippopotamus amphibius (The Hippopotamus)].

"'Mvu' of most local tribes.

"There are still plenty of this great beast in the Zambesi, but in the Loangwa River they are comparatively scarce. I found them abundant in the upper waters of the Kafue and obtained a fine old solitary male there. The river which is known to Europeans as the Kafue has, as a matter of fact, many native names in various parts of its course Kafue, Kafukwe, Kavu, Livu, Livubu, all of which signify the presence of this beast."

1 ♂.

[Giraffa camelopardalis (The Giraffe)].

"'Niamalikiti' of the Chikunda, 'Lumba' of the Asenga.

"There are a few of this animal still left in the mid-Loangwa Valley. They are now totally protected. A specimen, a fine old bull, shot by Mr. H. S. Thornicroft for the British South Africa Company, did not at first sight appear to differ materially from specimens of those from south of the Zambesi."

[Bubalis lichtensteini (Lichtenstein's Haartebeeste)].

"'Ngondo' of the Lake tribes, 'Nkonze' of the Asenga, 'Kondikondi' of the Alala.

"Common and widely distributed throughout the country, but prefers the more open districts of the high plateau, where it may often be seen in herds of from 20 to 30 individuals."

Two ♂ ♂.

[**Connochaetes taurinus** (The blue Wildebeeste)].

"'Nyumbu' of all the local tribes.

"This animal occurs very sparingly in the Loangwa Valley, especially to the north. I found it exceedingly shy and only obtained one specimen, a female."

1 ♀.

[**Cephalophus sylvicultor** (The yellow-backed Duiker)].

"'Chikwinti' of the Alamba.

"Appears to occur sparingly near the Upper Kafue. From a very circumstantial native story one specimen appears to have been recently trapped on the banks of the Loangwa River. It seems to be a very shy animal, inhabiting for the most part dense jungle."

1 ♂.

[**Cephalophus natalensis** (The red Duiker)].

"'Guapi' of the Chikunda, 'Insia' of the Asenga.

"This little buck is common all over the country. It seems to prefer somewhat wooded districts."

2 ♂ ♂.

Cephalophus nyasæ.

Cephalophus nyasæ, Thos., *Ann. Mag. Nat. Hist.*, (7), vol. 9, p. 58, 1902.

The specimen does not altogether agree with typical *nyasæ* especially in skull characters but neither does it agree with the description of *nyasæ defriesi*, Rothsch. This subspecies is based on specimens from the country between Mwaru and Tanganyika and also from the Kafue River, while typical *nyasæ* is from Mlanje, British Central Africa, so that geographical considerations are here no good in choosing a name. With only one specimen and without having seen the type of *defriesi* I prefer to call this specimen *nyasæ*.

"Inhabits dense jungle and is only obtained by snaring. It is called 'Campalanga' by the Alamba, and is said to feed largely on fruit."

Oreotragus aceratos.

Oreotragus aceratos, Noack, *Zool. Anz.*, p. 11, 1899.

29. A single ♂ from the hills near Petauke.

"'Chinkoma' of all the local tribes.

"Klipspringers are somewhat scarce throughout the country mainly, apparently, owing to the rarity of suitable localities."

[**Ourebia**, sp. (The Oribi)].

"Called 'Chosimbe' and 'Mphwintio' (in imitation of its cry) by the Asenga.

"Occasionally seen in pairs in the more open parts of the country."

Raphicerus sharpei.

Raphicerus sharpei, Thos., *P.Z.S.*, 1896, p. 796.

30 ♂. Near Petauke. Dec., 1905.

The type was from Angoniland; the present specimen is younger and has lighter horns and a greater proportion of white hairs on the back, but is undoubtedly *sharpei*.

"This species is fairly common throughout the country. It is not unlike a hare in its habits often lying close in the grass until nearly trodden on.

"It is called 'Kasenye' by the Lake tribes, 'Kafundu' by the Asenga, 'Timba' on the Alala Plateau."

[**Kobus vardoni** (The Puku)].

"'Seula' of most neighbouring tribes.

"The Puku is common near the larger rivers, especially near the Kafue. It is usually in herds of 20 to 30 individuals, containing, however, as a rule, only one adult male."

2 ♂ ♂.

[**Kobus ellipsiprymnus** (The common Waterbuck)].

"'Niakozwe' of the Chikunda, 'Chuzu' of the Asenga, 'Mkulu' of the Alala.

"A common antelope occurring in very large numbers on the banks of the Loangwa River. It does not, however, develop as large horns as South African examples. The largest I obtained measured 28¾ inches on the curve. I only heard of one specimen over 30 inches being shot. *Kobus defassa* (the Sing Sing) is reported from further north, as also is *Kobus leche* (the Lechwe), locally known as 'Inja.'"

2 ♂ ♂.

[**Aepyceros melampus** (The Palla or Impala)].

"'Mpala' of all local tribes.

"This antelope is very abundant throughout the Loangwa Valley, much scarcer on the plateau toward the Kafue. It affects a particular type of country, viz., the 'Mopani' flats, near the larger rivers, and is seldom seen elsewhere. It would seem to have a singular aversion to long grass or dense bush, and can scarcely be driven into it. Specimens from the Loangwa and Zambesi valleys are consistently much smaller both in bulk and in horns than those from British East Africa. A pair of horns measuring over 20 inches is exceedingly rare from this country."

2 ♂ ♂.

[**Egocerus equinus** (The Roan)].

"'Chiroko' of the Asenga, 'Mpewa' of the Alala.

"This is perhaps the commonest and most widely distributed of all the larger antelopes in the country. Specimens with long horns are however rare, especially on the Alala Plateau. This is not a little remarkable, as

from that country come the finest Sable horns in Africa. The explanation is probably to be looked for in the food supply, the Sable being much more of a leaf and shrub eater than the Roan. The idea that these two species do not occur together is quite erroneous, as they may be found together over a large area. I have even seen them feeding within a few hundred yards of each other."

1 ♂ ♂.

[**Egocerus niger** (The Sable)].

"'Mpalapala' of the Lake tribes, 'Ntuwakanwa' and 'Mpenembe' of the Asenga.

"The Black Bulls are called 'Niambuzi' or 'Ngombengombe' by the Asenga, and 'Nkumbi' by the Alala.

"There is some confusion in the native minds between the Sable and Roan, owing to the redness of the females of the former.

"Occurs in fair numbers on the higher plateau, especially towards the Kafue, where very large specimens are met with. I once met with a herd of over 50 individuals. The horns of the largest specimen brought to England measured nearly 48 inches on the curve. The Sable on this plateau belong to the form in which the cows do not darken with age, but remain a bright reddish colour."

2 ♂ ♂, 1 ♀.

[**Tragelaphus spekei** (The Situtunga)].

"'Sowe' of the Awisa.

"Is said to occur fairly numerously in the more northern portion of the territory."

1 ♂.

[**Tragelaphus**, sp. (The Bushbuck)].

"'Mbawala' of the Chikunda and Lake tribes, 'Mkwiwa' of the Asenga.

"Common in the more wooded parts of the country. It is somewhat wary and old males are hard to find."

1 ♂.

[**Strepsiceros strepsiceros**. (The Kudu)].

"'Ngoma' of the Lake tribes, 'Mpulupulu' of the Asenga.

"This magnificent antelope is fairly common and very widely distributed over the country, but is exceedingly wary."

1 ♂, 1 ♀.

[**Taurotragus oreas** (The Eland)].

"'Nchefu' and 'Nsefu' of Asenga and Lake tribes, 'Nsongo' of the Alala.

"The Eland is fairly numerous, preferring the more open country. The specimens I met with all belonged to the striped tan-coloured form."

[**Bubalus caffer** (The African Buffalo)].

"'Njati, nzati,' of the Lake tribes, 'Mboo' of the Asenga, 'Kakuli' of the Alala.

"Buffaloes are now exceedingly scarce having suffered much from the Rinderpest of some 10 years ago. There are still a few scattered herds of small size in the country. I succeeded in obtaining a solitary old bull the only one I met with."

1 ♂.

[**Manis**, sp.].

"A species of Manis appears to be known to natives from the mid Zambesi Valley, and it is not unusual to see its scales worn by them as charms. Further north, except from Nyasaland, I could hear of no record of its occurrence."

[**Orycteropus afer** (The Aard-vark)].

"'Mpendwa' of most native tribes.

"Common all over the country, but owing to its nocturnal habits never seen. It is very occasionally dug out of its burrow by natives."

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VI. The Grouping of the Chemical Elements

By C. E. STROMEYER, M.Inst.C.E.

Received and read January 15th, 1907.

This enquiry was started like many others in the hope of finding a formula which would express the atomic weights in terms of the positions in Mendeléeff's groups of chemical elements, but a few preliminary attempts led to the conviction that the formula would have to represent an undulating curve, and not a simple one like that suggested by Stoney. Also, all attempts to adopt periods of 16 group intervals or their multiples or parts failed, but by rearranging the chemical elements, regardless of their properties, in 15, 14, and fewer groups, a certain amount of harmony was discovered for systems having 12, 24, and 48 groups, and the following formula is the result:—

$$A = 2{\cdot}788\ldots N - 6{\cdot}0 + \left(-\frac{2.48}{N}\sin\frac{N.\pi}{48} + \frac{4.24}{N}\sin\frac{N.\pi}{24} + \frac{8.12}{N}\sin\frac{N.\pi}{12} \right)$$

which may be written

$$A = 2{\cdot}788\ldots N - 6{\cdot}0 + \frac{30{\cdot}56}{N}\left(-\sin N.3{\cdot}75^{\circ} + \sin N.7{\cdot}5^{\circ} + \sin N.15^{\circ} \right).$$

Here A is the atomic weight of the element which is separated from Helium by N group intervals.

A slight improvement might have been effected in the above formula by introducing a term of the form $C.\sin\frac{N\pi}{7}$, also by replacing 2·788 . . by 2·78

and by modifying some of the coefficients to suit, but it had already become evident that the formula is of no

March 7th, 1907.

scientific value, that it is purely empirical, and might perhaps with advantage have been replaced by a fair curve drawn by hand.

The discovery had been made that in general, the differences between the actual atomic weights and those found by the calculation from the group positions—being whole numbers—were practically of the same value for each one of Mendeléeff's groups. In other words, if the formula could have been reversed and the group positions calculated from the ascertained atomic weights, it would have been found that the group positions were not only not whole numbers, but also that the intervals between them were very irregular. The process actually adopted in the calculation of Table I. was to determine the average differences between the real and estimated atomic weights for each group, and thus fix its average position, and then to recalculate the atomic weights with these new values. The first group, headed by Lithium, may serve as an example. The preliminary calculation had fixed the position of this group at 1·04 (see table), the value of N for the individual elements was therefore as follows: Lithium 1·04, Potassium 17·04, Rubidium 33·04, Caesium 49·04. The calculation of the atomic weight of Potassium is as follows:—

$\frac{30{\cdot}56}{17{\cdot}04} = 17{\cdot}94$, $3{\cdot}75^{\circ} \times 17{\cdot}04 = 63^{\circ}{\cdot}54'$, $7{\cdot}5^{\circ} \times 17{\cdot}04 = 127^{\circ}48'$, $15^{\circ} \times 17{\cdot}04 = 255^{\circ}36'$, and the sines of these angles are:

$$+0{\cdot}8980, \quad +0{\cdot}7902, \quad -0{\cdot}9686.$$

Then we have

2·788 . . N	...	...	...	= +47·526
Less 6·0	...	...	...	− 6·000
				+41·526

Add	− 0·8980	
	+ 0·7902	
17·94	− 0·9686	
	1·0764	− 1·930

Calculated atomic weight of K = 39·596

All the other atomic weights have been calculated in the same way.

In the diagram, which reproduces the table, the intersections of the sixteen equi-distant vertical group lines, with the slanting group lines which are supposed to be drawn on a cylindrical surface, were marked with the atomic weights found by the formula, and the positions of the elements were then fixed by interpolation. Subsequently the elements of each of the groups were connected by lines. The Iron group is represented by three lines.

TABLE I.

*GROUPS OF CHEMICAL ELEMENTS.

Elements.		Atomic Weights.	Group Position.	Calculated At. Wt.	Difference.
GROUP O or XVI.		Mean position 15·93.			
Helium	He	4·00	16·00	3·84	+0·16
Argon	Ar	39 90	17·16	36·81	+3·09
Krypton.....	Kr	81·80	15·77	82·25	−0·45
Xenon	X	128·00	16·04	127·71	+0·29

* The grouping in this table is based on that of Mendeléeff, but with the atomic weights brought up to date. Recently discovered elements are also included.

Elements.		Atomic Weights.	Group Position.	Calculated At. Wt.	Difference.
GROUP I.		Mean position, 1·04.			
Lithium	Li	7·03	1·14	6·80	+0·23
Potassium	K	39·15	0·87	39·59	−0·44
Rubidium	Rb	85·40	1·13	85·17	+0·23
Caesium.....	Cs	132·90	1·64	131·05	+1·85
GROUP II.		Mean position, 1·72.			
Beryllium	Be or Gl	9·10	1·96	8·49	+0·61
Calcium.....	Ca	40·10	1·23	41·37	−1·27
Strontium	Sr	87·60	1·97	86·91	+0·69
Barium	Ba	137·40	3·13	133·20	+4·20
——	—	—	—	—	—
Radium	Ra	225·00	2·82	221·74	+3·26
GROUP III.		Mean position, 2·66.			
Boron	B	11·00	2·79	10·68	+0·32
Scandium	Sc	44·10	2·69	44·08	+0·02
Yttrium	Y	89·00	2·50	89·44	−0·44
Lanthanum ...	La	138·90	3·64	136·10	+2·80
Ytterbium	Yb	173·00	0·03	180·23	−7·23

Elements.		Atomic Weights.	Group Position.	Calculated At. Wt.	Difference.
GROUP IV_1.		Mean (first) position, 3·17.			
Carbon	C	12·00	3·24	11·84	+0·16
Titanium	Ti	48·10	4·08	46·49	+2·61
Zirconium	Zr	90·60	3·11	90·77	−0·17
Cerium	Ce	140·25	4·94	137·52	+2·73
——	—	—	—	—	—
Thorium	Th	232·50	5·62	225·92	+6·58
GROUP IV_2.		Mean (second) position, 4·09.			
Carbon	C	12·00	3·24	13·79	−1·79
Titanium	Ti	48·10	4·08	48·11	−0·01
Zirconium	Zr	90·60	3·11	93·22	−2·62
Cerium	Ce	140·25	4·09	140·24	+0·00
——	—	—	—	—	—
Thorium	Th	232·50	5·62	228·44	+4·06
GROUP V.		Mean position, 4·32.			
Nitrogen	N	14·04	4·22	14·24	−0·20
Vanadium	V	51·20	5·15	48·78	+2·42
Niobium	Nb	94·00	4·39	93·83	+0·17
Praseodymium	Pr	140·50	4·18	140·92	−0·42
Tantalum	Ta	183·00	3·67	184·83	−1·83

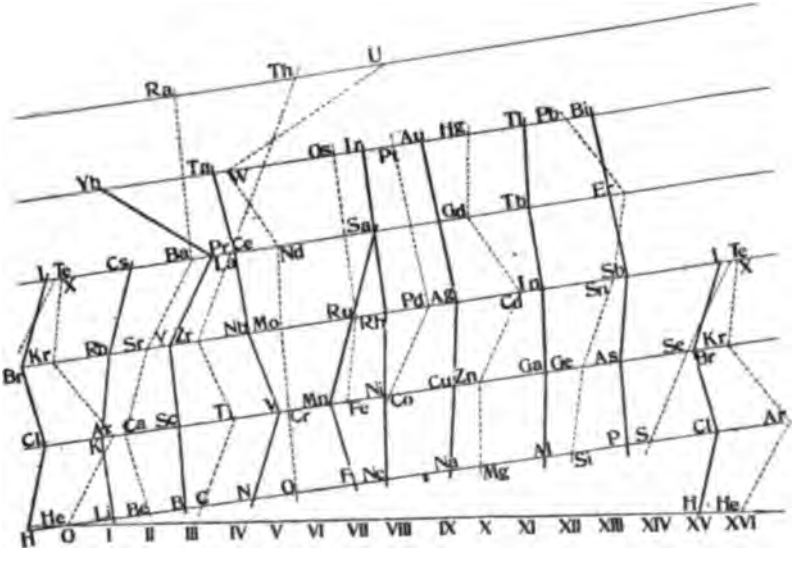
Elements.		Atomic Weights.	Group Position.	Calculated At. Wt.	Difference.
GROUP VI.		Mean position, 5·27.			
Oxygen	O	16·00	5·22	16·08	−0·08
Chromium.....	Cr	52·10	5·46	51·52	+0·58
Molybdenum...	Mo	96·00	5·14	96·38	−0·38
Neodymium ...	Nd	143·60	5·24	143·68	−0·08
Tungsten	W	184·00	4·03	187·50	−3·50
Uranium	U	238·50	7·81	231·60	+6·90
GROUP VII.		Mean position, 6·64.			
Fluorine	F	19·00	6·85	18·62	+0·38
Manganese ...	Mn	55·00	6·44	55·64	−0·64
——	—	—	—	—	—
Samarium	Sa	150·00	7·50	147·60	+2·40
GROUP $VIII_1$.		Mean position, 6·82.			
——	—	—	—	—	—
Iron	Fe	55·90	6·73	54·20	−0·70
Ruthenium ...	Ru	101·70	7·22	100·55	+1·15
——	—	—	—	—	—
Osmium.....	Os	191·00	6·51	191·87	−0·87

Elements.		Atomic Weights.	Group Position.	Calculated At. Wt.	Difference.
GROUP VIII$_2$.		Mean position, 7·59.			
Neon	Ne	20·00	7·42	20·30	−0·30
Nickel	Ni	58·70	7·65	58·52	+0·18
Rhodium	Rh	103·00	7·69	102·68	+0·32
——	—	—	—	—	—
Iridium	Ir	193·00	7·22	194·04	−1·04
GROUP VIII$_3$.		Mean position, 7·80.			
——	—	—	—	—	—
Cobalt	Co	59·00	7·75	59·16	−0·16
Palladium	Pd	106·00	8·75	103·30	+2·70
——	—	—	—	—	—
Platinum	Pt	194·80	7·85	194·65	+0·15
GROUP IX.		Mean position, 9·29.			
Sodium	Na	23·05	9·17	23·25	−0·20
Copper	Cu	63·60	9·28	63·55	+0·05
Silver	Ag	107·93	9·42	107·50	+0·43
——	—	—	—	—	—
Gold	Au	197·20	8·70	198·76	−1·56

Elements.		Atomic Weights.	Group Position.	Calculated At. Wt.	Difference.
GROUP X.		Mean position, 9·82.			
Magnesium ...	Mg	24·36	9·91	24·19	+0·17
Zinc	Zn	65·40	9·89	65·22	+0·18
Cadmium	Cd	112·40	10·94	109·09	+3·31
Gadolinium ...	Gd	156·00	9·68	156·35	−0·35
Mercury.....	Hg	200·30	9·79	200·38	−0·08
GROUP XI.		Mean position, 11·34.			
Aluminium ...	Al	27·10	11·41	26·96	+0·14
Gallium	Ga	70·00	11·50	69·55	+0·45
Indium	In	114·00	11·47	113·60	+0·40
Terbium	Tb	160·00	11·18	160·43	−0·43
Thallium	Tl	204·10	11·14	204·66	−0·56
GROUP XII_1.		Mean (first) position, 12·21.			
Silicon	Si	28·40	12·09	28·60	−0·20
Germanium ...	Ge	72·50	12·38	72·01	+0·49
Tin.....	Sn	119·00	13·12	116·22	+2·78
Erbium	Er	166·00	13·43	162·79	+3·21
Lead	Pb	206·90	12·14	207·09	−0·19

Elements.		Atomic Weights.	Group Position.	Calculated At. Wt.	Difference.
GROUP XII_2.		Mean (second) position, 13·27.			
Silicon	Si	28·40	12·09	30·82	− 2·42
Germanium ...	Ge	72·50	12·38	75·00	− 2·50
Tin.....	Su	119·00	13·12	119·46	− 0·46
Erbium	Er	166·00	13·43	165·57	+ 0·43
Lead	Pb	206·90	12·14	210·01	− 3·11
GROUP XIII.		Mean position, 13·38.			
Phosphorus ...	P	31·00	13·37	31·01	− 0·01
Arsenic	As	75·00	13·27	75·30	− 0·30
Antimony	Sb	120·00	13·51	119·80	+ 0·20
——	—	—	—	—	—
Bismuth.....	Bi	208·50	12·72	210·30	− 1·80
GROUP XIV.		Mean position undefined.			
Sulphur	S	32·06	13·87	—	—
Selenium	Se	79·20	14·80	—	—
Tellurium	Te	127·60	15·91	—	—

Elements.		Atomic Weights.	Group Position.	Calculated At. Wt.	Difference.
GROUP XV.		Mean position, 15·17.			
Chlorine	Cl	35·45	15·36	34·98	+0·47
Bromine	Br	79·66	14·97	80·18	−0·52
Iodine	I	126·85	15·67	125·31	+1·44
GROUP I. or XVI.		Hydrogen, 14·96.			
Hydrogen	H	1·008	14·96	1·008	0



An examination of the table shows a close agreement between the actual and the calculated atomic weights, the greatest discrepancies being those for Uranium, Thorium, Barium, Erbium, Cadmium, Radium, and Argon on the

one side, and for Bismuth and Ytterbium on the other. Most of these discrepancies are, however, to be found in the groups having even numbers, shown in dotted lines on the diagram, it being more especially their upper ends which are out of line. It will also be noticed that with the exception of the II. group in which the Calcium point bulges to the left, all the other even groups bulge to the right, in such a way as to make it appear probable that a very close agreement would be obtained if two formulas were used, one for the odd, the other for the even numbers of groups. The formula for the even groups would then have to contain an additional term of the form

$$3.\sin(N.7{\cdot}5^{\circ} - 45^{\circ}).$$

There is, however, no justification for this complication, yet this difficulty of harmonising the atomic weights suggests the possibility that Mendeléeff's grouping is not satisfactory, and that perhaps a more simple relationship than that indicated by the formula might be found by comparison not of the atomic weights but of the molecular weights. At any rate, if two molecules of Sodium naturally replace one of Magnesium and two-thirds of Aluminium, etc., why then should not there be a relationship between the atomic weights divided by the greatest valency of the elements, and why should not each element appear several times either as a simple atom or as a cluster of atoms? A table constructed on this principle has a very confusing appearance, but although no attempt has been made to enquire into this departure, it must not be overlooked that it is perhaps the only system in which a suitable place can be found for Hydrogen. In the present arrangement the Hydrogen position is the one for which N is minus one. It falls in line with the Chlorine group, but to suggest that on account of the negative value of N the chemical properties should be

reversed would be to endow the above empirical formula with a scientific value which it would be absurd to claim for it.

The mean positions of the groups are given in Table I., and have been summarised in Table II., which also contains the intervals between the groups, expressed in average group intervals.

It will be noticed that the (VII.) Fluorine, or rather Manganese, group and the ($VIII_1$.) Iron group, as well as the ($VIII_2$.) Nickel and the ($VIII_3$.) Cobalt groups, fall almost together, whereas the (VI.) Oxygen and (VII.) Fluorine groups, the ($VIII_3$.) Cobalt and the (IX.) Sodium groups, and the (X.) Magnesium and the (XI.) Aluminium groups, are separated by about three half average group spacings, and the distance of the mean (VIII.) Iron, Nickel, Cobalt groups from the (IX.) Sodium group is 1·89 average intervals. It will also be noticed that the (VI.) Oxygen group falls at 5·27, and the (XI.) Aluminium group falls at 11·34, so that between these two groups there are 6·1 spaces for five groups and only 9·9 spaces for eleven groups. The (IV.) Carbon and the (XII.) Silicon groups both seem to split up naturally into two sub-divisions, as indicated in Table I. These four might be called the Carbon, Titanium, Silicon, and Tin groups. The (XIV.) Sulphur group, as will be seen from Table I. and from the diagram, slants so considerably that the elements of which it consists are separated from one another by whole group intervals, and it would almost seem as if there should be not one group but three, for each of which, however, only one element had been discovered.

A considerable difference is also noticeable between the mean positions of groups which are separated by 8

of Mendeléef's intervals. This irregularity can be reduced by adding the term

$$-\sin\{(N-2)22{\cdot}5^{\circ}\}.$$

to the empirical formula, whereby the system is reduced to 8 groups. The table would now require re-calculating, and though some change in the group intervals would result, these would not differ materially from the mean intervals. As an example of the effect produced by the above added term in throwing together two groups 8 intervals apart, take the case of groups V. and XIII. Their mean group positions and the group positions of the individual elements are

TABLE III.

Elements	N	P	V	As	Nb
Group position	4·68	4·87	5·57	4·93	4·75
Difference from mean	−·07	+0·12	+0·82	+0·18	+0·0

Elements	Sb	Pr	—	Ta	Bi
Group position	5·21	4·50	—	4·01	4·38
Difference from mean	+0·46	−0·25	—	−0·74	−0·37

It will thus be seen that should Mendeléeff's system of grouping be correct, then the groups are irregularly spaced in the same way as the notes of the major or minor musical scale are irregular in relation to the tempered chromatic scale, in which each successive semitone has 5·95 per cent. more vibrations than the next lowest one.

It is a mere coincidence that the seven notes in one octave, whose correct relationship is expressed by the ratios of the multiples of the prime numbers 1, 2 and 3, should coincide with points of a scale representing compound interest of 5·95 per cent., which doubles itself in twelve intervals. The same coincidence does not exist with regard to the atomic weights but the irregular spacing of the groups suggests the probability that in this case, as in music, the relationship between the elements is not expressible by a continuous curve. The formula given in this paper may, however, be found useful in predicting the atomic weights of undiscovered elements, and possibly the irregular spacing of the groups may, as suggested by Stoney, indicate some of the properties of the elements, or the wide gaps between the groups may suggest their being filled up.

If the term

$$-\sin\{(N-2)22{\cdot}5^\circ\}$$

be added to the empirical formula, the sixteen groups can be reduced to eight, and their positions and intervals are as follows:—

Group ...	0 & 8	1 & 9	2 & 10	3 & 11	4 & 12	5 & 13	6 & 14	7 & 15	8 & 16
Group Position	−0·32	1·16	1·77	3·01	3·72	4·75	—	6 90	7·68
Intervals ...	1·44	0·61	1·24	0·61	1·03	say 1·07&1·08			0·78

These intervals are approximately 1 2/3, 2/3, 1 2/3, 2/3, etc., or as 2, 1, 2, 1, 2, 1, etc. Of course the discrepancies between the actual and the calculated atomic weights which in the present table are small, will be somewhat increased by such a rearrangement.

Table II.—MEAN POSITIONS OF GROUPS.

Groups.	No. of Elements.	Mean Positions.	Intervals.
——	—	—	—
——	—	—	—
O or ——	—	—	—
XVI. Helium	4	15·93	1·11
I. Potassium	4	1·04	0·68
II. Calcium	5	1·72	0·94
III. Boron	5	2·66	0·51
IV$_1$. Carbon	5	3·17	1·15
(IV$_2$. Titanium	5	4·09)	
V. Nitrogen	5	4·32	0·95
VI. Oxygen	6	5·27	1·37
VII. Fluorine	3	6 64	0·18
VIII$_1$. Iron	3	6·82	

Groups.	No. of Elements.	Mean Positions.	Intervals.
VIII$_1$. Iron	3	6·82	0·77
VIII$_2$. Nickel	4	7·59	0·21
VIII$_3$. Cobalt	3	7·80	
(VIII. Mean	10	7·40)	1·49
IX. Sodium	4	9·29	0·53
X. Magnesium	5	9 82	1·52
XI. Aluminium	5	11·34	0·87
XII$_1$. Silicon	5	12·21	
(XII$_2$. Tin	5	13·27)	1·17
XIII. Phosphorus	4	13·38	say 0·89
XIV. Sulphur	3	?	0·90
XV. Chlorine	3	15·17	0 80
XVI. Helium	4	15·97	

Note.—No differences have been taken for the bracketed groups.

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VII. On the Structure of Syringodendron, the Bark of *Sigillaria.*

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(Communicated by Professor F. E. Weiss, D.Sc., F.L.S.)

Read December 11th, 1906. Received for publication, January 29th, 1907.

In the spring of this year, some preparations of a plant from the Lower Coal Measures of Shore were sent to the Manchester Museum by Mr. Lomax, of Bolton. These were so different from any specimens yet received that it was very difficult to determine to what plant they belonged. They were evidently tangential sections through the bark of some large plant, but the block from which they were cut contained no remains of the vascular tissue of the plant. The greater part of the tissue consisted of elongate periderm cells between which were embedded at fairly regular intervals large oval patches of thin-walled cells sharply differentiated off from the surrounding tissues, and about half an inch long by a quarter broad. (See *Fig.* 1 of the Plate.)

Professor A. C. Seward has suggested that this bark may have been that of a *Sigillaria* in the condition known as Syringodendron, which is characterised by the possession of similar large oval marks generally arranged in rows. A comparison of the sections with several specimens of Syringodendron in the Manchester Museum confirms Professor Seward's identification. The patches

in the sections are in long double rows, the horizontal distance between these being about an inch and a half. The vertical distance between two consecutive pairs in the same double row is half an inch, and between the two members of one pair, rather more. This arrangement exactly corresponds with that found in one part of a large

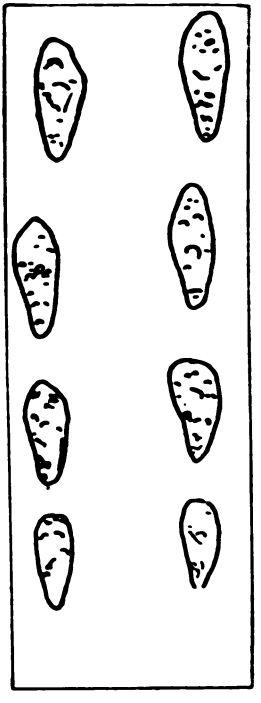

FIG. 1. Parichnos scars on impression specimen. (Nat. size to compare with Fig. 1 of Plate).

compressed specimen in the Museum. (See *Fig.* 1 in the text and compare with *Fig.* 1 of the Plate.) On the same specimen single rows are also found, and these are somewhat bilobed or indented at the top, and as transition stages from the double row to the single are also seen, it

is evident that the double row is formed by the branching of each strand in the single row.

These scars are generally interpreted as having been caused by the parichnos strands which are usually seen as two small marks on the leaf scar, but are of somewhat larger dimensions below the leaf cushion, as can be seen in partially decorticated specimens. (See *Fig.* 2 in the text.) In the specimen from which the sections were taken, and also in some other specimens of Syringodendron, the very large scars would appear to have been due to subsequent growth of the parichnos strands as they become nearly an inch in length.

In the sections the periderm cells are much elongated and sclerised, and are closely packed together. Towards

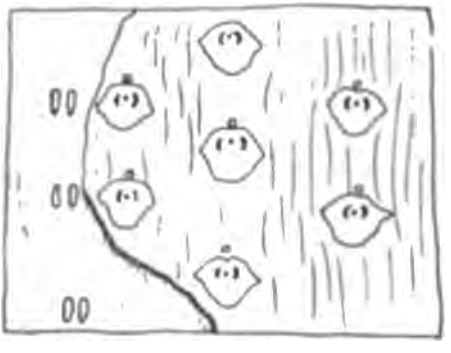

FIG. 2. *Sigillaria Brardi* with bark slipped slightly to the right and displaying Syringodendron markings. (After Weiss.)

the patches of thin-walled tissue they become shorter, and end in a layer of thick-walled cells, which forms a very definite margin to the oval patches of tissue. (See *Figs.* 2 and 3 of the Plate.) The cells in these patches are fairly uniform and well preserved, thin-walled, and in most cases devoid of cell contents; but there are many groups of cells with contents which may be the preserved

remains of protoplasmic activity, such as mucilage, in which case these sections certainly lend support to the view that the parichnos strands remain, and enlarge as secretory organs. In the impression specimens, however, the scars have numerous little lumps or "roughnesses," which are probably these groups of cells preserved, and it seems much more likely that these cells have once been sclerised, but the thickening of the walls has been so acted upon by acids that it has swelled up, and is no longer recognisable as such. In view of the persistence and enlargement of the parichnos strands there is reason to suppose that they were respiratory in function, and the sclerised patches may have served the purpose of support. The strands may then be directly compared with the lenticels of Dicotyledons with which they would be analogous though not, of course, homologous.

In the sections and in the impression specimens which shew a similar stage of decortication, no trace of the vascular strand which accompanies the parichnos to the leaf can be distinguished. The vascular tissue, having become useless when the leaf has fallen off, has not continued its growth, and while the remains of the bundle become less conspicuous, the enlarged parichnos strands become more so. In different specimens of impression, material, every gradation of size of parichnos strand, can be traced from one sixteenth of an inch in diameter on small stems, to an inch in the largest ones.

Comparing these various stages with the sections under consideration, there seems to be no doubt that they agree, and the structure material really must be that of Syringodendron ; and although we have thus obtained sections of the structure material of the enlarged parichnos strands, their function is not entirely settled by it, though the evidence at present seems greatly in favour of the

view that they act as respiratory organs by keeping open a free passage between the outside air and the inner tissues of the plant.

Parichnos strands in a fairly good state of preservation, and very similar to the above have been described and figured by Seward and Hill in their paper "On the Structure and Affinities of a Lepidodendroid Stem from the Calciferous Sandstone of Dalmeny, Scot., possibly identical with Lepidophloios Harcourtii (Witham,)" published in the *Transactions of the Royal Society Edinburgh*, vol. 39, part 4.

EXPLANATION OF THE PLATE.

FIG. 1. Tangential longitudinal section of Syringodendron consisting of long periderm cells with two double rows o parichnos strands cut transversely. Natural size.

FIG. 2. Tangential longitudinal section of the same, shew ing one parichnos strand with surrounding periderm cells, an the groups of cells with contents just indicated. (× 6.)

FIG. 3. Tangential section of the same, shewing the end o one parichnos strand and periderm cells. For further descrip tion, see the text. (× 15.)

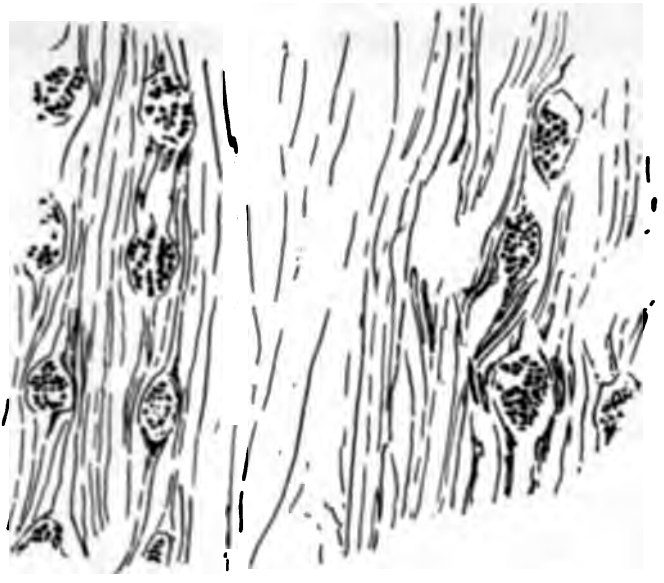

FIG. 1.

FIG. 2.

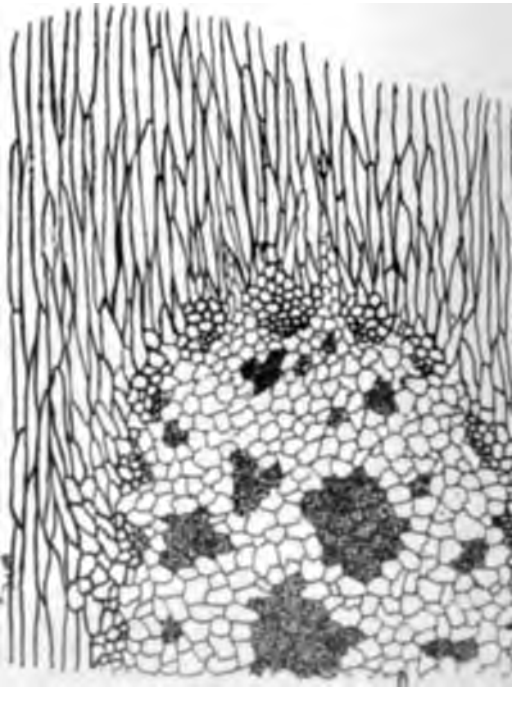

FIG. 3

Manchester Memoirs, Vol. li. (1907), *No.* 8.

VIII. The Parichnos in the Lepidodendraceæ.

By F. E. WEISS, D.Sc.,

Professor of Botany in the University of Manchester.

Read December 11th, 1906. Received for publication February 13th, 1907.

The term parichnos (from παρὰ = beside and ἴχνος = a footprint) was used by Bertrand ('91) to describe two lateral prints on the leaf scar of the Lepidodendraceæ which stand on either side of the vascular bundle. These marks can be clearly seen on any well preserved leaf scar both in *Lepidodendron* and in *Sigillaria* (see *Text-figs.* 1 and 2).

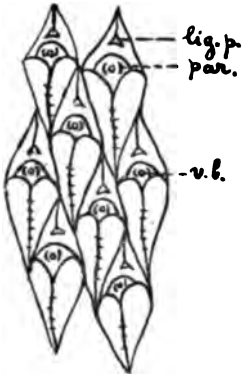

Fig. 1.—Leaf bases of *Lepidodendron* showing leaf scars with marks of vascular bundle (*v.b.*) and of parichnos strands (*par*). The ligular pit is also seen (*lig.p*).

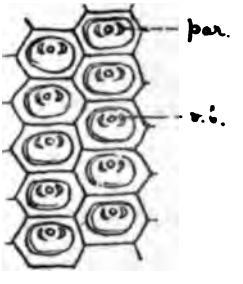

Fig. 2.—Leaf bases of *Sigillaria* showing similar marks on the leaf scar.

At first these lateral marks were supposed to be the scars of lateral bundles given off in the leaf base by the

central vascular bundle; but this view was shown to be erroneous by Renault ('75), who found that in *Sigillaria*, at all events, the tissue coming to the surface at these points was parenchymatous and not vascular.

As these lateral marks in *Sigillaria* agreed so closely with those of *Lepidodendron*, it was clear that they were homologous structures, and consequently here, too, as Solms-Laubach ('91) pointed out, they could no longer be considered as vascular. Subsequent investigations by Bertrand ('91) and Hovelacque ('92) have shown that both in *Lepidodendron Harcourtii* and in *Lepidodendron selaginoides* these parichnos-scars communicate with strands of parenchymatous cells in the leaf cushion as is the case with the similar lateral scars in *Sigillaria*. If one traces these parichnos strands through the leaf base into the stem, one finds that they unite in the leaf base into a single somewhat kidney-shaped strand which, running on the underside of the vascular bundle, penetrates together with it the periderm and the hard outer cortex, and joins the soft and often lacunar middle cortex of the stem. This can be seen from the series of excellent drawings made by Hovelacque of the leaf trace of *Lepidodendron selaginoides* at different positions in the cortex, whence we can discern that the parichnos makes its appearance as a parenchymatous strand, accompanying the leaf trace on its entrance into the outer cortex ('écorce moyenne' of Hovelacque). (See Hovelacque ('92) *Text-figs.* 35 to 37.) Similar figures of the course and bifurcation of the parichnos strand have been figured by Williamson in the case of *Lepidophloios fuliginosus*. (See Williamson ('93), *Figs.* 31 to 37).

None of these figures, however, show the actual union of the parichnos strand with the middle cortex, though this continuity was recognised by the above

authors. It can, however, be seen in *Text-fig.* 3 of the present communication, drawn from a longitudinal section of *Lepidodendron selaginoides* which shows the passage of the parichnos canal, its tissue being defective, into the space occupied formerly by the mid-cortex of the stem.

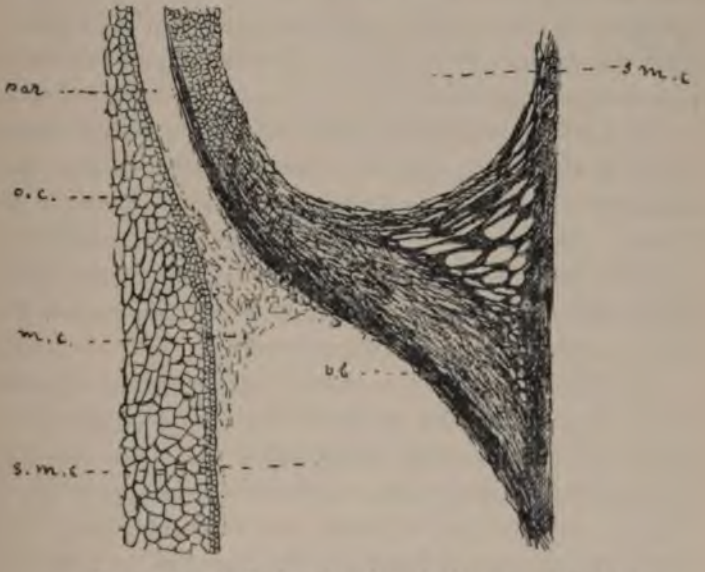

Fig. 3.—Longitudinal section through the stem of *Lepidodendron selaginoides* showing the parichnos strand (*par*) in continuity with the remains of the mid-cortex (*m.c.*). *s.m.c.* = space left by defective middle cortex. *v.b.* = vascular bundle running from central cylinder to outer cortex (*o.c.*) and accompanied below by the parichnos strand.

A figure showing the parichnos strand of *Lepidophloios fuliginosus*, consisting of large rounded parenchymatous cells, joining the well-preserved middle cortex of the axis was figured by me (:03) in the *Transactions of the Linnean Society* (*pl.* 26, *fig.* 15).

Interest in the nature and function of the parichnos has been renewed by the recently completed account by

T. G. Hill (:06) of the occurrence of similar structures in the leaves of recent Lycopodiales, more especially in the sporophylls, and these structures he considers to be phylogenetically identical with the parichnos of the Lepidodendraceæ. Potonié ('99) had already drawn attention to the resemblance between the mucilage passages of *Lycopodium* and the parichnos of *Lepidodendron*,* though he considered the function of the two sets of organs to be different.

Hill has extended the comparison to *Isoëtes hystrix* where a double strand of tissue comparable with the parichnos exists. In *Lycopodium* the mucilage duct is single. This does not however lessen the possibility of their being homologous structures, as Maslen ('99) has found *Lepidostrobus*, the cone of *Lepidodendron*, to have an unbranched parichnos strand.

As Hill mentions, the state of preservation of the parichnos strand varies considerably. In some cases we have very well preserved parenchymatous cells as seen in the figures of *Lepidodendron selaginoides* in M. Hovelacque's *Memoir*, and still more so in the longitudinal section mentioned above, and figured in the *Trans. of the Linnean Society* (Weiss, :03). In other cases, such as those figured by Mr. Maslen, the parichnos strand is represented by empty canals showing no cellular tissue at all.

As this latter is also the condition in the mature tissues of those living Lycopodiaceæ in which secretory strands have been observed, while the young organs have a very definite tissue in this position, Mr. Hill concludes that in fossil forms, too, the empty canal is the mature structure, while the well preserved condition represents the immature stage. This might possibly apply to the parichnos strands occurring in the sporophylls, but as

* Potonié ('99), p. 239.

regards the vegetative organs, the explanation must, I think, be a different one. For the Halonial stem described by me (:03) must have been a fully developed axis, as is indicated both by its size and also by the secondary thickening which it had undergone. The stem, too, of which *Fig.* 1 of the *Plate* of this *Memoir* is taken was certainly a mature stem, and yet the parichnos tissue is entirely well preserved and obviously not secretory. The better preservation seems to me to be entirely due to the firmer nature of the mid-cortex, of which the parichnos is an extension. On the other hand, quite young stems of *Lepidodendron selaginoides* may have a defective parichnos tissue, but then they have a defective middle cortex as well. Of course if we assume the parichnos canal to have been primarily a secretory canal, the more defective might represent the more mature tissue. But though admitting that the corresponding tissue in recent plants is secretory, forming as it does a mucilage canal, yet we may well suppose that in the more elaborate Lepidodendraceæ the function may have been a different one, though a secretory function is by no means excluded. Hovelacque '92, indeed, considered the parichnos strand primarily glandular, and Renault, too, compared the tissue to gum canals. If secretory one would expect the tissue to end abruptly both in the leaf and in the stem as it does in the recent plants in which it has been described by Hill. But in the fossil plants the parichnos strand goes off insensibly on the one hand into the mesophyll of the leaf, and in the other direction into the mid-cortex of the stem from which it is in no way separated off or differentiated in structure, as can be seen in the best preserved sections.

Potonié '97 and '99 has attributed to the parichnos strands a transpiratory function, and compares them with

the curious strands of parenchymatous cells running through the awn of the barley, and which, according to Mikosch ('92), are concerned in increasing the evaporation of water. Such a function might be quite in consonance with the actual structure of the parichnos tissue, but it would not explain the continuation of this tissue into that of the lacunar middle cortex of the stem. One would expect a tissue concerned in transpiratory processes to be definitely connected with the vascular tissue of the leaf base, as the mesophyll of the leaf is through the intermediary of the transfusion cells. But of such connection there is no sign in any of the Lepidodendraceæ, the parichnos running on the outer or phloem side of the leaf trace. Moreover, there seems no reason in the case of the vegetative leaves to make special provision for facilitating the transpiration, when one remembers the xerophytic nature of the leaves of *Lepidodendron* and particularly of *Sigillaria*. In both cases the stomata are sunk in narrow grooves, such as one finds in recent plants requiring to reduce the evaporation of moisture from their leaves. Special transpiratory strands would be in direct opposition to the whole structure of the leaf.

Dr. Scott (:00) considers the function of the parichnos strands somewhat problematical (p. 145), but believes that while it is highly probable that they were in part secretory, "the persistence and enlargement of the parichnos on the surface of old stems suggests a respiratory function like that of lenticels" (p. 202). With this latter view I agree entirely.

The parichnos strand, connecting as it does the delicate and lacunar tissue of the mid-cortex with the intercellular spaces of the leaf, and consequently through the intermediary of the stomata, which are found in the longitudinal grooves of the Lepidodendroid leaf, with the surrounding

atmosphere, enables the inner living tissues of the stem, such as the cambium, for instance, to be supplied with the necessary oxygen. The transpiration of the plant is probably sufficiently maintained by the transfusion tracheids which connect the vascular bundle with the mesophyll of the leaf. A respiratory passage through the dense outer cortex, and the impervious periderm would seem to be an essential requirement of the Lepidodendroid stem. And as the vascular tissue of the leaf trace cannot supply this want, a passage of parenchymatous cells parallel to the leaf trace undertakes this function. An examination of these parenchymatous cells in their best preservation, shows that the tissue is well provided with intercellular spaces. In some cases, indeed, the tissue seems to have been more or less lacunar, and hence often defective in preservation. If we were to look for a tissue with analogous function among recent Lycopodiales, we should probably find it in the trabecular tissue surrounding the stele of *Selaginella*.

This view seems to me to be in complete consonance with the actual structure of the parichnos strands seen in their best preservation. It need not exclude the possibility of the parichnos acting in a secretory capacity in some instances as indeed Scott (:00) has suggested. As stated above the parichnos strands are visible when the leaf has fallen away, as two lateral marks on the leaf scar, which is situated at the end or in the middle of the leaf cushion in the different genera of the Lepidodendraceæ. The very distinct appearance of this strand on the leaf scar is suggestive of its having still some part to play in the life of the plant, and if its function was a respiratory one, then the parichnos scars may be aptly compared in function to the lenticels of the higher plants as indeed has been done by Scott, Potonié, and others. This would

sufficiently account for the retention of these parichnos scars in all their distinctness after the fall of the leaves.

That the parichnos scars continued their function for some considerable time may be gathered from the fact that in some old stems of *Sigillaria*, even after the leaf scars have disappeared, the parichnos strands can be observed. The fossils formerly described as *Syringodendron* are now known to be the decorticated stems of various species of *Sigillaria* on which, though the leaf cushion can no longer be seen, the underlying bark shows sometimes the scar of the vascular bundle, but more generally only two very large parichnos scars. These are indeed often of such dimensions, being sometimes nearly an inch in length, that one cannot help concluding that this organ was endowed in some Sigillariæ with powers of growth after the fall of the leaf, and thus came very near the lenticels in structure as well as function.*

Some markings very like those of *Syringodendron* were observed by Stur ('77) in *Lepidophloios crassicaulis*, and also by Potonié ('99) in a *Lepidophloios* in the collection of the Prussian Geological Museum in Berlin. According to Potonié's figure (223), two longitudinal patches of tissue come into appearance in those parts where the reflected leaf bases are in part broken away. These scars are, as Potonié shows, patches of the parichnos strands laid bare, and he considers that on the under surface of the reflected leaf base the parichnos strands come very close to the surface, and suggests that the epidermis disappears at this point, and that the parichnos strands are thus exposed. (See *Text-fig.* 4.) I have examined very carefully several sets of well preserved

* For further information, see the paper of Miss K. Coward "On the Structure of *Syringodendron*," *Memoirs of the Manchester Lit. and Phil. Soc.*, vol. 51, No. 7, 1907.

radial and tangential sections of *Lepidophloios*, without being able, however, to confirm Potonié's view that the parichnos strands were exposed directly. In specimens

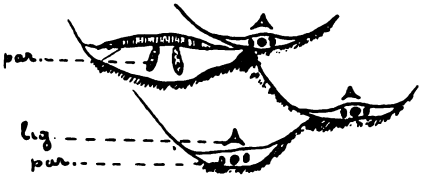

Fig. 4.—Leaf bases of *Lepidophloios* (after Potonié) showing parichnos strands (*par*) on leaf scars and also (to the left) on leaf base where overlying tissue has broken away. *lig.* = ligular pit.

which are particularly well preserved, and which show the parichnos tissue in its entirety similar to the section figured by Scott (:00), *fig.* 57. There is no indication of any break in the epidermis, but the parichnos strands run for some way very close to the surface and communicate with a very delicate subepidermal tissue containing well developed intercellular spaces. This tissue must have been defective in the specimens examined by Potonié, for in his drawing of the leaf base it is represented by a large lacuna. The tissue was undoubtedly a spongy parenchyma or an aerenchyma, with either transpiratory or respiratory function, or possibly both. But as far as I can make out in *Lepidophloios* it was always covered over by an epidermis, and whenever this is seen at all in surface view, or even occasionally in sectional view, it seems to be provided with numerous stomata, offering a very efficient communication with the exterior. These stomata, opening as they did on the under surface of the reflexed leaf base would be well protected against rapid transpiration, and at the same time provide the necessary air channels through the hard periderm to the interior of the stem. It would seem therefore that when

the parichnos strand is laid bare as in Potonié's figure, it is by subsequent breaking of a portion of the leaf base.

In some species of *Lepidodendron*, however (*e.g.*, *L. aculeatum*, *L. sternbergi*, etc.), there appear below the leaf-scar two very definite oblong marks, one on either side of the median line, which, as Scott mentions, seem to have some connection with the parichnos, and to which Potonié compares the scars of *Lepidophloios* mentioned above. These marks on the leaf-cushion (see *Text-fig.* 5), which were called "vascular glands" by Stur ('77),

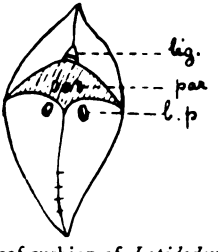

Fig. 5.—Leaf cushion of *Lepidodendron* showing the lateral pits (*l.p.*) beneath the leaf-scar, on which the ends of the parichnos strands are seen (*par*). *lig.* = ligular pit.

have been compared by Solms Laubach ('97) to the orifices on the leaf-stalks of tree ferns, and Potonié ('97) approves of this comparison, though at the same time maintaining that their function is a transpiratory one.

I have been able to study from a series of sections in the Manchester Museum the nature of these lateral scars and their relation to the parichnos strands in a *Lepidodendron*, the internal structure of which showed it to be of the "*Harcourtii* type," though differing from the typical *Harcourtii* in some respects.*

* It resembled very closely the *Lepidodendron* figured by Williamson in *Memoir* XIX., and which Mr. D. M. Watson, who is reinvestigating this form considers to be a different species, and proposes to call *Lepidodendron Hickii*.

The leaf cushions, as can be seen both from transverse and tangential longitudinal sections, were diamond shaped, their long axis coinciding with that of the stem, so that they were of the Lepidodendron rather than the Lepidophloios type. In transverse sections the parichnos strands can be seen running almost horizontally in the leaf base, often showing very clearly the bifurcation (see *Fig.* 1 of *Plate*), which takes place in the leaf base and not in the outer cortex as has sometimes been stated. In some instances the parichnos strand can be followed to quite near the edge of the cushion, and it will be seen to join two patches of specialised cells close below the leaf scar, on either side of the median ridge of the leaf cushion. That is the case in *Fig.* 1, where the left-hand branch of the parichnos is not yet in touch with the exterior, while the right-hand branch (the section being slightly oblique), which is cut a little higher up, joins a pit-like depression partially filled with a group of cells which will be described in more detail a little further on. That these cells lie a little below the leaf scar is indicated by the presence of a median ridge which disappears on the leaf scar itself.

At the point where the parichnos strand stops, there is a gap probably due to the delicate nature of the cells which join the parichnos to the group of specialised cells, which in the sections have slipped somewhat out of their position. An examination of the cells on either side of this gap shows that the tissue in which the split has taken place consisted of exceedingly small stellate cells (st c. in *Fig.* 2 of *Plate*), much smaller than the cells of the parichnos strand, or of any of the neighbouring tissues.

These stellate cells were, by their shape, separated from each other by wide intercellular spaces, and formed consequently an admirable "aerenchyma" similar to that

found in the ground tissue of many recent aquatic and marsh plants. This stellate tissue appears at first sight to go over towards the outside into a tissue consisting of large rounded cells (see *Fig.* 2 of *Plate*); but a careful examination of this tissue leads me to think that the large white areas of this tissue are not cell cavities, but round intercellular spaces lying between small slightly irregular, or sometimes even rectangular cells. This it is difficult to make out from the tissue which is dark and dense, but a detailed study of it in various sections, particularly the transition to it from the stellate cells makes it the more probable explanation, and brings it into consonance with the structure of the underlying

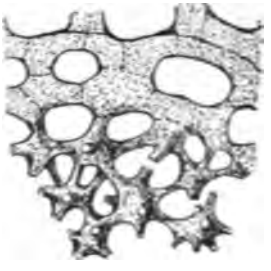

Fig. 6.—The Stellate tissue (aerenchyma) in which the parichnos strands terminate in *Lepidodendron Harcourtii* slightly diagrammatic.

tissue of stellate cells (c.p. *Text-fig.* 6). I believe that all this tissue to which the parichnos strand joins up is aërenchymatous, and it is in close agreement with such tissue as one finds, for instance, in the roots of some of the mangrove plants, such as *Avicennia*, where we also get a transition from somewhat stellate cells to a tissue of smaller and more rectangular cells surrounding large intercellular spaces.

What was the external boundary of this aërenchyma, I am unable to state. The preservation of the tissue is

not sufficiently good to allow this to be definitely determined. A consideration of *Fig.* 2 of the *Plate* leads one to suppose that if replaced into its normal position adjoining the parichnos strand (par.), it would not come up to the surface of the leaf base, but terminate in a slight depression, and from the appearance of longitudinal sections I conclude that it was covered in by an epidermal layer, provided with numerous stomata, as seems to be the case with the epidermal layer overlying the parichnos strands of *Lepidophloios*. In *Lepidophloios*, where I have also found aerenchyma in connection with the parichnos strand, the reflexed and imbricating leaf-bases offer some protection against undue evaporation from the parichnos strands, while in *Lepidodendron* the aerenchyma communicates with the exterior through stomata, set in a depression, and thus also preventing undue transpiration, while giving every facility for the aeration of the plant.

That such pit-like depressions which can only be inferred from the transverse sections actually exist, becomes evident from an examination of a series of tangential sections taken through the leaf-cushions of a *Lepidodendron* (see *Fig.* 3 of *Plate*). Examining a series of these, one sees that they are lozenge-shaped and vertically elongate. Those cut close to the axis show the leaf-trace and a single parichnos strand. A little nearer the outside the parichnos strand divides into two, and almost at the same time one notices traces of the ligular pit showing that this organ must have been very deeply set. A little further from the stem, two cavities lined with dark epidermal cells make their appearance (p. in *Fig.* 3, 1 of *Plate*), and these on sections cut a little further from the base open out on either side of the median ridge (*Fig.* 3, II. of *Plate*), thus showing that they were the inner terminations of pit-like depressions, which

open out more and more widely as they approach the leaf-scar. There can be little doubt from their position, that these pit-like depressions correspond with the inferior scars noticed on the impressions of many Lepidodendron leaf-bases. Now, what is the relation of these pits to the parichnos strands? In the sections in which these pits first make their appearance, they are separated from the parichnos strands by some six or eight layers of undifferentiated cells; but as soon as they communicate laterally with the exterior, one can see a patch of specialised cells on the wall of each pit (aer., *Fig.* 3 (iv.) of *Plate*) close to the underlying parichnos strand, and subsequently in contact with it. The glandular appearance which these patches have, is I believe due to defective preservation, though undoubtedly a different explanation might be put upon it. They are covered in by a more or less distinct epidermal layer, though in some cases it is defective. I have not been able to observe any stellate cells such as occur in the transverse sections; but this may be due to two causes. In the first place we have no certainty that this *Lepidodendron* is the same species as that of which the transverse sections above are figured and described. Secondly, the transverse sections described above must have passed somewhat obliquely through the aërenchyma, and the stellate cells may on the tangential section of the leaf-base be much less conspicuous. What is, however, obvious on these tangential sections is that the parichnos is separated from the glandular-looking tissue by a layer of small cells which correspond in position with the stellate cells described above. Beyond these small cells the tissue, which, as stated, is very defective, consists of larger elements, or of cells with larger air spaces, but they have undergone so much degeneration that it is impos-

sible here to say definitely that it consisted of aerenchyma. But the general concurrence with the transverse sections leads me to suppose that this was the case, and I believe we may conclude that the inferior scars were really respiratory cavities, and were intended to reduce rather than to accelerate the transpiration from the leaf-bases.

Reconstructing from the series of tangential sections, the appearance of the leaf-base as it would appear in a radial section, one would get the appearance seen in *Text-fig.* 7. This section is not quite median so as to show the parichnos strand and the lateral pits. Projecting this section on to a plan, one sees that it gives one the picture of a typical leaf-base of a *Lepidodendron*.

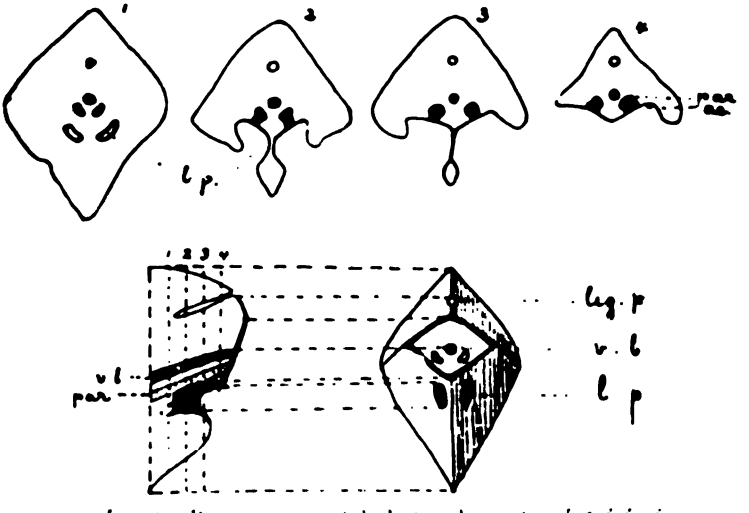

Fig. 7. Reconstruction of the leaf cushion of a *Lepidodendron* (probably *L. p. Hutt.*) from four tangential sections similar to those in *Figs.* 3 of *Plate*.

v. l. vascular bundle. *lig. p.* ligular pit. *par.* parichnos strands. *l. p.* lateral pits running into the leaf cushion below the parichnos strands. *a.* aerenchymatous tissue clothing the top of the lateral respiratory pits. In the radial longitudinal section on the left hand side the membrane separating the two lateral pits is indicated by oblique shading.

It will be seen that the radial section of the leaf cushion has somewhat the aspect of that figured by Williamson ('93) (see pl. III., *fig.* 19), of which he says that the margin of the leaf was "more deeply lobed than usual." This lobing is really the beginning of the lateral pit, his section, though passing through the vascular bundle, being slightly oblique, and not following the crest of the leaf-base. A section a little more out of the median would show even a deeper lobing, as in the reconstructed one, *Text-fig.* 7.

In his excellent memoir of *Lepidodendron selaginoides*, Hovelacque, has figured a series of tangential sections, which show that in this species there also existed a pit-like depression running into the body of the leaf cushion.

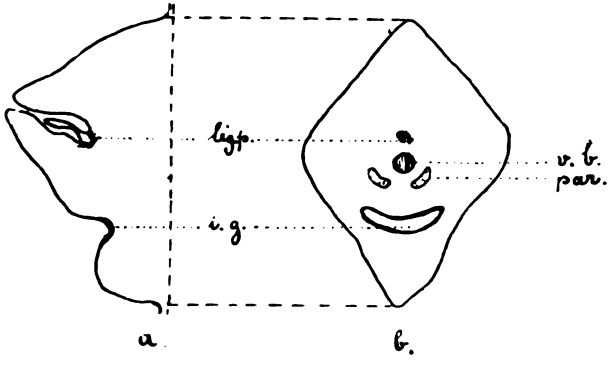

Fig. 8.—Radial (*a*) and tangential (*b*) sections through the leaf cushion of *Lepidodendron selaginoides* (diagrammatic after Hovelacque) showing the inferior groove *i. g.* (sillon inférieur) which corresponds to the lateral pits of other Lepidodendra.
lig. p. = ligular pit. *v. b.* = vascular bundle. *par.* = parichnos.

This is plainly seen in the figures (*figs.* 2 and 3 of pl. IV.) of his memoir, and still more clearly in *fig.* 3 of pl. V. To this depression, which is shown in radial view on *fig.* 6, pl. VII., Hovelacque has given the name of "sillon inférieur," as it comes close below the leaf scar. It differs, as is

directly apparent (see *Text-fig.* 8), from the similar pits described above, in the fact that we have there only a single cavity running right across the leaf cushion in the form of a groove. This groove Hovelacque has represented diagrammatically in *fig.* 41, p. 82, and though so different in aspect from the lateral pits, it may possibly have served the same function. Hovelacque, it is true, does not mention any connection between it and the parichnos strands, but in his figures on pl. IV. there seems some evidence that the parichnos strands come close to the surface in this sillon, and that there were some specialised cells lining the upper surface of this groove.

If special provision is made by the parichnos strands for the respiration of the stem in the Lepidodendraceæ, we should also expect that some provision would have been made for those parts of *Lepidodendron* and *Sigillaria*, which were embedded in the water-logged soil of the marsh in which they are supposed to have been rooted. As far as the Stigmarian axis is concerned, it would no doubt receive the air necessary for its respiration through the lacunar tissue of the mid-cortex, which we must suppose to have been in continuity with that of the aerial stem, and thence through the parichnos tissue with the mesophyll of the leaf, or in addition, through the lateral pits more directly with the exterior. But the Stigmarian appendages or rootlets would also require air for respiratory purposes, and their very defective mid-cortex suggests that it was through this tissue that the air must have reached the rootlet from the rhizom. The rootlet, as is well known, springs from a rootlet cushion of apparently parenchymatous cells on the outside of a dense mass of cortex, and partly of periderm, through which the vascular bundle passes out into the rootlet. Is this periderm layer penetrated like

that of the stem by any strand of thin-walled parenchymatous cells, provided with intercellular spaces capable of conveying air to the rootlet? Is there anything corresponding to a parichnos strand of a leaf? As a matter of fact this is the case, and *Fig.* 4 of the *Plate* shows the group of small parenchymatous cells accompanying the rootlet bundle on its way outward through the outer cortex in a Stigmaria, described by Hick ('92), under the name of *Xenophyton.* An examination of a series of sections shows that this parenchymatous group is in continuity with the mid-cortex of the Stigmarian axis, and it must therefore be regarded as the equivalent of the parichnos strand of the leaf cushion. In my re-description of *Xenophyton* (:02), I mentioned the continuity of this small-celled tissue below the rootlet bundle with the mid-cortex, but the correspondence of it with the parichnos of the leaf cushion did not then occur to me. It will be noticed that this "parichnos" of the rootlet running on the underside of the rootlet bundle, is really on the morphologically upper, *i.e.*, apical side of the Stigmarian axis, and consequently on the xylem side of the bundle, not on the phloem side, as in the case of the parichnos, which runs in connection with the leaf trace. This strand of middle-cortex cells runs right through the outer cortex and periderm to the "cushion" from which the rootlet springs, and there passes into the close parenchyma of which the cushion is largely formed. No doubt this parenchyma had intercellular spaces; and indeed in very well-preserved Stigmariæ they are apparent, though very small, and through them communication was set up between the lacunar mid-cortex of the Stigmarian axis and that of the rootlet. Thus air could be brought to reach the rootlets or Stigmarian appendages, which we believe to have been embedded in a water-logged medium. This correspondence

in structure between the leaves and root will undoubtedly be used by those who believe in the morphological identity of these organs in support of their contention. Nevertheless, we may, I think, equally well maintain, without adopting that view, that in both cases for similar purposes a communication has been established between the aerenchyma of a lateral organ (leaf or rootlet) and that of the axis (stem or rhizom) to which it belonged. It will, I think, be obvious that the presence of an aerenchymatous strand running to the rootlets, lends additional support to the view that the parichnos was concerned in maintaining the respiration rather than the transpiration of the plant; for the roots surely could have no transpiratory function to perform.

The parichnos in the Lepidodendraceæ had the function of taking in air through the leaf or through the leaf-base, and of conducting it inwards to the stem and downwards to the Stigmarian rhizom, and even into the lateral organs (rootlets) of the same. The whole structure of the parichnos and its mode of communicating with the exterior is in consonance with this view.

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EXPLANATION OF PLATE.

Fig. 1. Transverse section (magnified) across the leaf cushion of a *Lepidodendron*, allied to *Lep. Hickii.*, showing the bifurcation of the parichnos strand (par.). The right hand branch opens into a pit-like depression, partly filled with aërenchyma, which has become slightly displaced. (R 275.)

Fig. 2. Enlarged view of portion of *Fig.* 1, showing the aërenchyma, at the base of which is a cluster of small stellate cells (st.c.). Compare this figure with *Text fig.* 1.

Fig. 3. Part of a tangential section of stem which has cut across four leaf cushions. No. I. is cut nearest the stem, then II., III., and IV. in series. In I. the two lateral pits are seen to run deep into the leaf cushion, and at this point are not connected with the parichnos strands. In II. the parichnos strands come closer to the pits, and these are seen opening out on either side of the median ridge of the leaf cushion. In III. the lateral pits are more widely open. IV. is cut close below the leaf scar, and the pits are now no longer seen, but aërenchyma lies below the epidermis and adjoins the tissue of the parichnos. (Enlarged 4 times.) (R 269 in the Manchester Museum collection.)

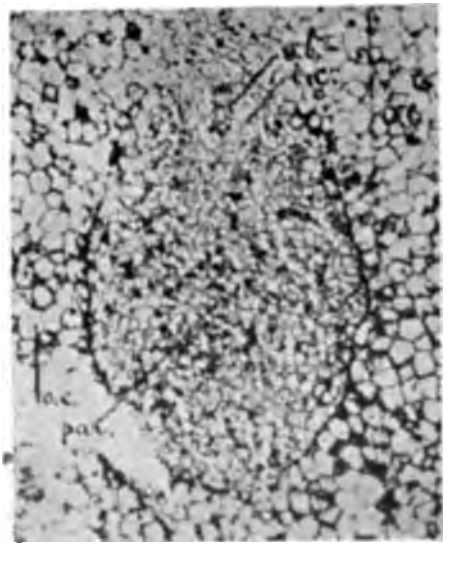
Fig. 4. A transverse section across the vascular bundle (v.b.) of a Stigmarian rootlet on its way out through the hard outer cortex (o.c.). It is accompanied on its lower side, which lies towards the apex of the Stigmarian axis, by a group of parenchymatous cells, in continuity with the middle cortex, and consequently homologous with the parichnos of the leaves. (Q 148.)

Fig. 1.

Fig. 3.

Fig. 2.

Fig. 4.



Manchester Memoirs, Vol. li. (1907), *No.* 9.

IX. Report on the Recent Foraminifera from the Coast of the Island of Delos (Grecian Archipelago). Part IV.

By HENRY SIDEBOTTOM.

Received and read February 26th, 1907.

NODOSARINÆ.

Nodosaria, Lamarck.

***Nodosaria calomorpha**, Reuss (Pl. 1, figs. 1—8).

Nodosaria calomorpha, Reuss ('65), p. 129, pl. 1, figs. 15-19.

N. (*Dentalina*) *consobrina*, Parker and Jones ('65), p. 342, pl. 16, fig. 3.

N. calomorpha (Reuss), Brady ('84), p. 497, pl. 61, figs. 23-27.

N. calomorpha (Reuss), Chaster ('92), p. 63, pl. 1, fig. 12.

N. calomorpha (Reuss), Morton ('97), p. 118, pl. 1, fig. 6.

In the varieties of this species, such as are shown in figs. 1 and 2, the tests are exceedingly delicate and transparent. Figs. 5 and 6 might easily be taken for *Lagena bottelliformis*, Brady, but I believe they are detached chambers from forms like figs. 3 and 4. Fig. 7 is compressed and fig. 8 only slightly so.

***Nodosaria (D.) communis**, d'Orbigny.

Dentalina inornata, d'Orbigny ('46), p. 44, pl. 1, figs. 50, 51.

D. badenensis, d'Orbigny ('46), p. 44, pl. 1, figs. 48, 49.

Nodosaria (*D.*) *communis* (d'Orb.), Brady ('84), p. 504, pl. 62, figs. 19-22.

The specimens are typical. Rare.

* The asterisk denotes that this species occurs at Palermo.

Nodosaria proxima, O. Silvestri (Pl. 1, figs. 9-11).

Nodosaria proxima (Silvestri), Jones ('96), p. 219, pl. 7, fig. 15, and ('66), pl. 4, fig. 8.

N. proxima (Silvestri), Brady ('84), p, 511, pl. 64, fig. 15.

Four specimens of this bilocular form of *Nodosaria* were found, three of which I have drawn. In the one not figured the initial chamber is free from costæ, and is distinctly larger than the second one. The test is furnished with a small spine at its base, and its mouth is phialine. The diameters of the two chambers in fig. 11 are equal. The test in this figure is free from costæ, has no spine, and the mouth appears to have been broken off. Fig. 9 also appears to be fractured in the same way. Fig. 10 has no costæ on the initial chamber, and the mouth has been damaged in the same manner.

Mr. Millett in his Malay report (:02), p. 520, says regarding the bilocular forms of *N. scalaris*, Batsch, that those specimens in which the costæ are absent, cannot be distinguished from *N. simplex*, Silvestri, and that this latter may well be regarded as the smooth condition of *N. scalaris*. *N. scalaris* has not been found in the Delos material, so fig. 11 appears in this case to be an example of the smooth form of *N. proxima*, Silvestri. Very rare.

* **Nodosaria chrysalis,** n. sp. (Pl. 1, figs. 12-14).

Test elongate, generally curved and very transparent. Primordial chamber very minute, followed by broad chambers; these rapidly increase in size until the middle of the test is reached, when two or three chambers are generally added, slightly decreasing in width, but gaining in height. The oral end of the test is round in outline, and the mouth is simple and has a short entosolenian

tube. The sutural lines are sunk, except at the aboral end, and the chambers are in consequence somewhat inflated. The test is very slightly compressed.

Three examples occur in which the test is straight, and these bear a striking resemblance to Terquem's *Dentalina affinis*, fig. 18, pl. 27 ('70). It is possible that this form would have been as well placed by putting it into the Genus *Lingulina*. Rather rare.

Lingulina, d'Orbigny.

*** Lingulina carinata,** d'Orbigny (Pl. 1, figs. 15-17, 18? 19?).

Lingulina carinata, d'Orbigny ('39), p. 124, pl, 1, figs. 5, 6.

L. carinata (d'Orb.), Williamson ('58), p. 14, pl. 2, figs. 33-35.

L. carinata (d'Orb.), Brady ('84), p. 517, pl. 65, figs. 16, 17.

The examples are not typical, the aperture being situated at the end of a short neck, with the exception of about six, which have an entosolenian tube, as in fig. 17. Some thirty specimens were found, most of them having four chambers. Figs. 18, 19, show two forms which have only two chambers, and may or may not belong to this species; four were found like fig. 18, and appear to have an orifice at each end of the test. About twenty like fig. 19 occur, and it is possible these may be double specimens of *Lagena lævigata*, but the number found rather precludes this idea. The type is better represented at Palermo, though very rare.

*** Lingulina carinata** (d'Orbigny), var. **bi-carinata,** nov. (Pl. 1, fig. 20).

This variety has two keels running round the edge of

the test. Five were found, of which four are three-chambered. The test is compressed, and the orifice, which is very minute, is apparently situated between the keels as shown in the end view. The shell figured is the largest of the set. Very rare.

Lingulina armata, n. sp. (Pl. 1, fig. 21).

The test of this minute species consists of two chambers, both of which are compressed, the primordial one being armed with small spines along nearly the whole of its periphery. The second chamber is narrow and the orifice oval. In all cases there is a short entosolenian tube This interesting little foraminifer may be an arrested form (or even a double *Lagena staphyllearea*). Six specimens occur. Very rare.

***Lingulina pellucida,** n. sp. (Pl. 1, figs. 22-25).

Primordial chamber oval, round in section, the following chamber slightly embracing it. This second chamber larger, compressed, and on either side at its base, armed with a small spine. Aperture oval in a phialine neck. Sometimes a third chamber is added, either slightly embracing the second chamber as in figs. 24, 25, or separated from it merely by the phialine neck of the latter, whose lip is only embraced, see fig. 23. This lip is visible inside the third chamber. Three examples like fig. 23 occur, and only in one case are the spines present on the third chamber. Eight similar to figs. 24, 25, were found, and about one hundred and fifty like fig. 22. Mr. Millett in his Malay Report (:02), p. 524, states that I had written to him saying that I had found six specimens of the three-chambered variety. This was evidently an error on my part, eleven being the correct number, three

large and eight small. Rather rare at Palermo. Mr. Millett considers my Delos specimens are closely related to his *L. limbata* ('92), p. 523, pl. 11, fig. 15.

Frondicularia, Defrance.

Frondicularia spathulata, Brady (Pl. 1, fig. 26).

Frondicularia spathulata, Brady ('84), p. 519, pl. 65, fig. 18.

I think the three specimens found may be brought under this species. The one figured has an entosolenian tube, but this is absent in the other two. Brady in the Challenger Report states that "this is one of the narrow compressed Nodosarian shells that might with almost equal propriety be placed either with *Lingulina* or *Frondicularia*, the slightly inflated primordial chamber, and bent earlier segments suggesting somewhat greater affinity to the latter genus." Very rare.

Frondicularia pygmæa, n. sp. (Pl. 1, fig. 27).

The initial chamber appears to be nearly globular, and the following ones are compressed, narrow and reflexed. The septa are arched, and slightly sunk, and the orifice is simple. A small wing commencing on the last chamber but one, runs on either side of the test, gradually broadening out and terminating as a spine. The initial chamber is likewise armed with a small spine.

Two specimens were found, and both consist of five chambers. One of the tests had the spines fractured when found, and the other one was broken in like manner during the process of examination. Very rare.

Marginulina, d'Orbigny.

Marginulina glabra, d'Orbigny (Pl. 1, fig. 28).

Marginulina glabra (d'Orb.), Brady ('84), p. 527, pl. 65, figs. 5, 6.

M. glabra (d'Orb.), Flint ('99), p. 313, pl. 60, fig. 1. Only one found.

* **Marginulina costata,** Batsch, sp. (Pl. 1, figs. 29-32).

Nodosaria proxima (Silvestri), Fornasini ('88), p. 48, pl. 3, figs. 10, 11.

Marginulina costata (Batsch), Millett ('02), p. 526, pl. 11, fig. 20.

Fornasini, in the above reference, states that there are two examples of *Nodosaria proxima*, Silvestri, in which the disposition of chambers, and of the aperture, approaches very much to that of a *Marginulina*. Some of the Delos specimens agree very closely with Fornasini's figures. About forty examples occur. The second chamber is usually smaller than the initial one, but in some cases they appear to be of equal size. I cannot see my way to separate forms like fig. 29 from the rest; in my view the whole forty belong to one species, and consist of examples having three, four, and five segments, and in one case six. The longest tests are nearly always curved. The neck is always at one side. Its length varies considerably, as does also the amount of inflation of the final chamber. Rather rare.

Vaginulina, d'Orbigny.

Vaginulina legumen, Linné, sp. (Pl. 1, fig. 33).

Dentalina legumen, Williamson ('58), p. 21, pl. 2, fig. 45.

Vaginulina legumen (Linné, sp.), Brady ('84), p. 530, pl. 66, figs. 13-15.

Two broken specimens only were found.

Cristellaria, Lamarck.

***Cristellaria crepidula,** Fichtel and Moll, sp.
(Pl. 2, fig. 1).

Nautilus crepidula, Fichtel and Moll (:03), p. 107, pl. 19, figs. g—i.

Cristellaria (F. and M.), d'Orbigny ('39), p. 64, pl. 8, fig 17, 18.

C. Crepidula (F. and M.), Brady ('84), p. 542, pl. 67 figs. 17, 19, 20, and pl. 68, figs. 1, 2.

Only two typical examples were found, and four fragments. A fair number of small specimens occur which I think may be brought under this heading, and I have chosen one for illustration. It agrees with the others, excepting that its segments are rather more lobulated, and that it has an extra chamber or two, the last of which is more inflated than the preceding ones. Much better examples of the type form occur at Palermo.

Cristellaria wetherellii, Jones, sp. (Pl. 2, fig. 2)
= Cristellaria fragraria, Gümbel.

Cristellaria wetherellii (Jones), Brady ('84), p. 537, pl. 114, fig. 14).

C. fragraria (Gumbel), Burrows and Holland ('97), p. 38, pl. 3, figs. 1-16.

One single specimen found; it is in good condition. The longitudinal costæ are confined to the earlier portion of the test, which is slightly compressed.

***Cristellaria cultrata,** Montfort, sp.

Robulina subcultrata, d'Orbigny ('39), p. 26, pl. 5, figs. 19, 20.

Cristellaria cultrata (Montfort), Parker and Jones ('65), p. 344, pl. 13, figs. 17, 18 and pl. 16, fig. 5.

The specimens are so small and clear that it is difficult to make out whether there is a true keel or not, but on the whole I am inclined to think they are starved forms of *C. cultrata.* Rather frequent.

***Cristellaria variabilis,** Reuss? (Pl. 2, fig. 3.)

Cristellaria variabilis, Reuss ('50), p. 369, pl. 46, fig. 15, 16.

C. variabilis (Reuss), Brady, Parker and Jones ('88), p. 222, pl. 44, fig. 12.

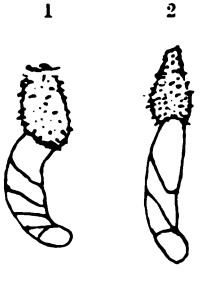
C. variabilis (Reuss), Flint ('99), p. 316, pl. 63, fig. 1.

One doubtful example has been found in this material, and this has unfortunately been lost in the post; I had, however, made a drawing of it, see Pl. 2, fig. 3. The test is compressed and not keeled. A few beautiful elongate examples occur at Palermo, which are keelless, and one orbicular specimen with a small keel.

Amphicoryne, Schlumberger.

Amphicoryne, sp.? (Pl. 2, figs. 4-10, and Text-figs. 1, 2.)

It is difficult to assign their proper position to these examples. There are about twenty-five specimens, eight



Amphicoryne, sp.? from Palermo. × 50.

of which show a change of structure with the change of growth, viz., by adding a chamber which is hispid and

inflated. At Palermo, fourteen were found, of which eleven have the hispid chamber. They seem too complete a series to be considered as monstrosities. Figs. 4, 5, 6, no doubt are young examples, and belong to the same series.

The tests (with the exception of the primordial and final chambers) are compressed, and, having oblique sutures and marginal apertures, would appear to be Vaginuline in their manner of growth. Fig. 8 is a side view of the test. The specimens from Palermo are rather more regular in form than those from Delos, as may be seen from the two outlined above.

POLYMORPHININÆ

Polymorphina, d'Orbigny.

***Polymorphina lactea**, Walker and Jacob, sp. (Pl. 2, fig. 11.)

Polymorphina muensteri (W. & J.), Reuss ('55), p. 249, pl. 8, fig. 80.

Globulina roemeri, Reuss ('55), p. 245, pl. 6, fig. 63.

Polymorphina lactea (W. & J.), *typica* (pars), Williamson ('58), p. 71, pl. 6, fig. 147, and *P. lactea* (W. & J.) var. *communis*, Williamson ('58), p. 72, pl. 6, figs. 153-155.

P. lactea (W. & J.) Brady, Parker and Jones ('70), p. 213, pl. 39, fig. 1.

Even allowing considerable latitude as to variations in form, this species is rare in the Delos material. The example figured is not typical.

Polymorphina amygdaloides, Reuss. (Pl. 2, figs. 12-14.)

Polymorphina amygdaloides, Reuss ('55), p. 250, pl. 8, fig. 84.

P. amygdaloides (Reuss), Brady, Parker and Jones ('70), p. 214, wood cuts.

P. amygdaloides, Terquem ('78), p. 39, pl. 3, figs. 25, 29, 30.

The Delos examples vary considerably as regards size, the very small ones being furnished with an entosolenian tube.

Polymorphina lactea (W. & J.), var. **oblonga**, Williamson.

Polymorphina lactea (W. & J.), var. *oblonga*, Williamson ('58), p. 71, pl. 6, fig. 149.

P. oblonga (Williamson), Brady, Parker and Jones ('70), p. 222, pl. 39, fig. 7.

P. oblonga (Williamson), Terquem ('75), p. 37, pl. 5, fig. 11.

The type is very rare, but there are a few that cannot well be brought under any other heading.

***Polymorphina gibba**, d'Orbigny. (Pl. 2, figs. 15, 16, 17.)

Globulina gibba, d'Orbigny ('46), p. 227, pl. 13, figs. 13, 14.

Polymorphina lactea (W. &. J.), Parker and Jones ('65), p. 359, pl. 13, figs. 45, 46.

Globulina gibba (d'Orb.), Terquem ('75), p. 43, pl. 4, figs. 1-5.

A good many specimens of this species were found, which are nearly globular in shape. Elongate examples like figs. 16, 17, are also present, along with others of more irregular form. Some of the smaller specimens agree in various points with those figured in d'Orbigny's Vienna Memoir, under the names of *Globulina punctata*

and *G. tuberculata.* These points of agreement are the contour of the tests, and their having delicate surface markings which cause unevenness; I am unable, however, to satisfy myself as to their identification with d'Orbigny's drawings. Frequent.

Polymorphina rotundata, Bornemann, sp. (Pl. 2, fig. 18.)

Guttalina rotundata (Bornemann), Brady, Parker and Jones ('70), p. 234, figs. K.L.M.

Rostrolina, Von Schlicht ('70), No. 412, p. 72, pl. 26, figs. 13-15.

Polymorphina rotundata, Reuss ('70), p. 487, No. 14; Schlicht, *op. cit.,* pl. 26, figs. 13-15, pl. 28, figs. 1-5, pl. 30, figs. 33-40.

P. turgida, Reuss, *op. cit.,* p. 487, No. 10; Schlicht, *op. cit.,* pl. 28, figs. 6-10, pl. 29, figs. 1-5.

A few of the specimens appear to be almost identical with Bornemann's figures in the above reference, and some of those that have fewer chambers seem to agree with *Polymorphina sororia,* Reuss, but the Delos specimens of these two species run into each other to such a degree that they cannot be separated. Frequent.

* **Polymorphina communis,** d'Orbigny.

Polymorphina communis, d'Orbigny ('46), p. 224, pl. 13, figs. 6-8.

Globulina irregularis, Id., ibid., p. 226, pl. 13, figs. 9, 10.

Polymorphina semiplana, Reuss ('70), p. 488, No. 16; Schlicht ('70), pl. 27, figs. 22-33.

P. Problema, var. *communis,* Reuss, *op. cit.,* p. 487, No. 15; Schlicht, *op. cit.,* pl. 30, figs. 13-16.

P. communis (d'Orb.), Brady, Parker and Jones ('70), p. 224, pl. 39, fig. 10.

P. communis (d'Orb.), Bagg ('98), p. 60, pl. 6, fig. 2.

Polymorphina problema, d'Orbigny. (Pl. 2, fig. 19.)

Guttalina problema, d'Orbigny ('46), p. 224, pl. 12, figs. 26-28.

G. austriaca, *Id. ibid.*, p. 223, pl. 12, figs. 23-25.

Polymorphina problema (d'Orb.), Brady, Parker and Jones ('70), p. 225, pl. 39, fig. 11.

P. problema (d'Orb.), Brady ('84), p. 568, pl. 72, fig. 20, and pl. 73, fig. 1.

Very fine and typical examples occur of the above two forms. Brady, Parker, and Jones in their monograph of the genus state "that the two forms inosculate to such an extent that it seems impossible to draw any line of demarcation between them," and this is the case with the Delos forms. Frequent, and rare, respectively.

Polymorphina oblonga, d'Orbigny. (Pl. 2, fig. 20.)

Polymorphina oblonga, d'Orbigny ('46), p. 223, pl. 12, figs. 29-31.

P. guttata, Reuss ('70), p. 487; Schlicht ('70), pl. 30, figs. 25-32.

The tests are not typical, but I think they must be brought under this head. They come nearest to Schlicht's figures in the above reference, which are referred by Reuss to this species. They vary a good deal in the proportion between the length and breadth of their tests, and also as to the inflation of the chambers. One fairly typical test in the fistulose condition was found. Rare.

Polymorphina irregularis, d'Orbigny. (Pl. 2, fig. 21.)

Polymorphina irregularis, d'Orbigny ('39), p. 137, pl. 2, figs. 12, 13.

P. irregularis (d'Orbigny), Brady, Parker and Jones ('70), p. 239, pl. 41, fig. 29.

The solitary specimen found is not so neat as the one figured by d'Orbigny, the costæ are also not so distinct, but it answers very well to the description of the species.

***Polymorphina compressa**, d'Orbigny. (Pl. 3, figs. 1-6, 12, 13).

Polymorphina compressa, d'Orbigny ('46), p. 223, pl. 12, figs. 32-34.

P. compressa (d'Orb.), Goës ('94), p. 58, pl. 10, figs. 539-553.

P. compressa (d'Orb.), Flint ('99), p. 319, pl. 67, fig. 3.

This species is more abundant than any other of this genus, and it varies in size from the large thick-shelled variety, such as figs. 1, 2, down to the small, smooth, thin, transparent forms with entosolenian tube as in figs. 5, 6. The majority of them approach in character the specimen represented by fig. 3. *About 10 are in the fistulose condition. Very frequent.

Polymorphina myristiformis, Williamson. (Pl. 3, fig. 7.)

Polymorphina myristiformis, Williamson ('58), p. 72, pl. 6, figs. 156, 157.

P. myristiformis (Williamson), Brady, Parker and Jones ('70), p. 240, pl. 41, fig. 30.

The ornamentation of this pretty foraminifer varies considerably; in some the lower half of the test is inclined to be tubercular, while the upper half has interrupted costæ. These costæ are sometimes strong as in the example figured, and sometimes very faint. A few of the Delos specimens approach Karrer's *P. ornata* ('68), p. 175, pl. 4, fig. 10, both in the shape of the test and in the markings. Rather rare.

Polymorphina lactea, var. **concava**, Williamson. (Pl. 3, figs. 8, 9.)

Polymorphina lactea, var. *concava*, Williamson ('58), p. 72, pl. 6, figs. 151, 152.

P. concava (Williamson), Brady, Parker and Jones ('70), p. 236, pl. 40, fig. 32.

This curious little foraminifer seems to have a place of its own among the Polymorphinae. Williamson's description of this species runs as follows:—"Its centre consists of a small hyaline shell of the ordinary type, but the last segment is spread out into a thin marginal expansion; highly concave on one surface, where the previous segments are but faintly visible (fig. 152) and equally convex on the other, where the earlier segments of the shell are more conspicuous. The periphery is always sinuous, and though very thin, is rounded and obtuse. The last segment presents no visible septal orifice. I am disposed to believe that during the formation of the ultimate segment, the individuals belonging to this variety may have become parasitic upon some other rounded bodies; an opinion to which the variable contour of the peripheral segment, contrasted with the uniform appearance of the central ones affords some countenance." Now, the last segment referred to in the above quotation I think may be understood to have a floor which attaches itself to the lower surface of the shell, and is shaped according to the object to which it is adherent. This forms a chamber, the sides of which spring like an arched ceiling, until they reach the upper surface of the shell, thus completing a chamber round the central test. About twenty specimens were found, of which fifteen are attached to various objects, generally on their more or less flat surface, but in one case the test is attached in the

angle formed by two chambers of a *Miliolina*. A few are upon what appear to be thin pieces of shale.

There is no doubt in my mind that the free specimens found have all been adherent.

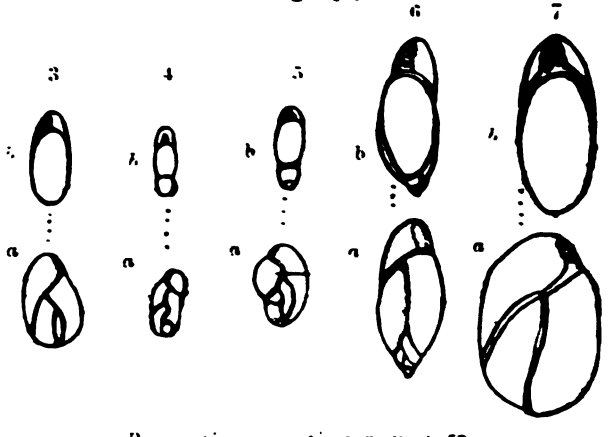
These specimens, like the one figured, have, generally speaking, the floor intact, but in one or two cases this floor has come off, and reveals very perfectly what a curious dissolving-out of the chambers of the central shell has taken place. Fig. 8, of Pl. 3, shows this shell viewed from the underside. The underside of the central test is almost level with the edge of the encircling chamber, and is simply supported in its place by the arched props which spring from the sides of the front part of the central shell; all the internal walls of the chambers being dissolved, leaving only the back and front, on which the sutural lines are still to be seen. In all cases where the test has become detached and the floor broken, this condition is revealed; when the floor remains, and is clear enough to see through, either dry or when damped, I think it is likewise present, at any rate to some extent. The arches supporting the back of the shell are not always as regular as in the example chosen for illustration. The dotted lines in fig. 9c. give some idea of the position of the floor, or underside of the test. To prevent confusion I have not indicated the arches. Brady in the Challenger Report ('84), p. 563, refers to this breaking up of the chamber walls in *Polymorphina angusta*, Egger. In a note at the end of this part, reference will be made to this peculiarity in the Polymorphinæ found at Delos. At Palermo this form is minute and very rare. Rather rare.

***Polymorphina spinosa**, d'Orbigny, sp var. (Pl. 3, figs. 10, 11.)

Globulina spinosa, d'Orbigny ('46), p. 203, pl. 13, figs. 23, 24.

The Delos specimens seem to be intermediate, and to lie between *P. spinosa*, d'Orbigny and *P. hirsuta*, Brady, Parker and Jones '70', p. 243, pl. 42, fig. 37. The shape of the test is not so globular as in the type, and the segments are more inflated. The tests are often adherent, and in this state they are frequently fixed in an angle, or cavity, of a broken shell by means of the spines, which are short or long as necessity requires. About twenty-five have been found. Rare.

Polymorphina? complexa, n. sp. (Pl. 4, figs. 1-9 and Text-figs. 3-7.)



Polymorphina? complexa, n. sp. × 50.

I am much puzzled as regards the genus of this species. The specimens vary in size, and in the disposition of the segments, as reference to the figures will show. A good many could be arranged round forms like figs. 1-4, of the rest hardly two are alike. All have the mouth cribrate, as far as I can make out. They at once arrest attention by their colour, which is of a very delicate pale ivory, and they are generally semi-transparent. Some would pass for *Bulimina* if the aperture were typical, but taken as a whole (and there are about one hundred and twenty-five

specimens), they seem to be more characteristic of the Polymorphinæ.

The specimens run into each other to such an extent that it seems useless to give varietal names. Very frequent.

Note on the Absorption of the Septal Walls in Polymorphinae.

In my remarks on *Polymorphina concava*, Williamson (page 14), I drew attention to the absorption of the septal walls in that species. I believe that this peculiarity is common, to a greater or less extent, to most, if not all of the different species of *Polymorphina* that occur in the Delos material, for, in the whole range, where the shells are sufficiently transparent, I have not been able to satisfy myself that this phenomenon is not present. In very many cases the absorption is not complete, a neat opening only, varying in length and width according to the size and shape of the septal wall, having been dissolved out.

This opening is often very apparent in the wall between the two last chambers. I have broken open some semi-opaque specimens from different species, and in all cases the septal walls, or at least some of them, are wholly, or partially destroyed. There are about twenty specimens which I have brought together under the name of *Polymorphina oblonga*, d'Orbigny (see Pl. 2, fig. 20), the tests of which are very clear. Now, in the majority of these it is certain that some of the septal walls show the opening in question, and probably the remainder would be proved to possess it upon more careful examination. In looking at the *Polymorphina*, in my general collection of Foraminifera from different localities, I find

this peculiarity is present, but to what extent, it would be hazardous to say. It looks as if the protoplasm preferred to make a free opening in the wall of the chamber (and a more central one in regard to the new chamber to be formed) rather than to exude itself through its ordinary minute mouth when the time for extension of premises arrived. I suppose we shall have to wait until the life history of some of the species is written before the true explanation can be arrived at. Brady ('84, p. 563) has drawn attention to this peculiarity in some of the tests of *P. angusta*, Egger (a small, starved, deep-water form), but I do not remember seeing any references by him to other species showing the same phenomenon.

Carpenter, in the "Introduction to the Study of the Foraminifera" ('62), p. 168, says, "It is a curious fact that when an outer 'wild-growing' segment extends itself over the whole of the preceding series, its cavity communicates, not merely by the usual radiated aperture, with the antepenultimate chamber, but also by a double row of openings with all the chambers which it overlaps. It is difficult to suppose that these openings existed anteriorly to the overgrowth; and we can scarcely account for their presence in any other way, than that they have been formed *de novo* by absorption."

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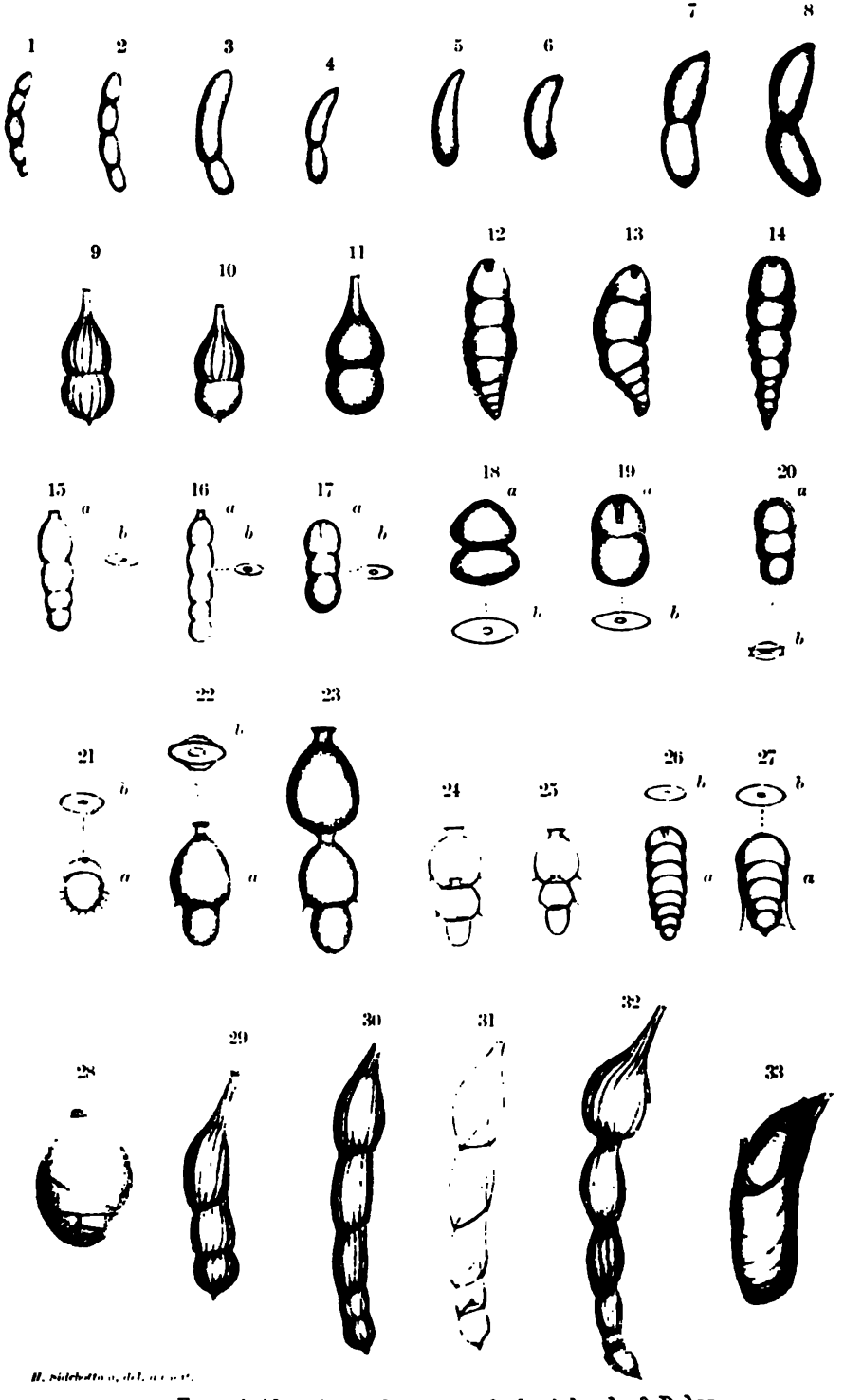

H. Sidebotham, del. et sc.

Foraminifera from the coast of the island of Delos.

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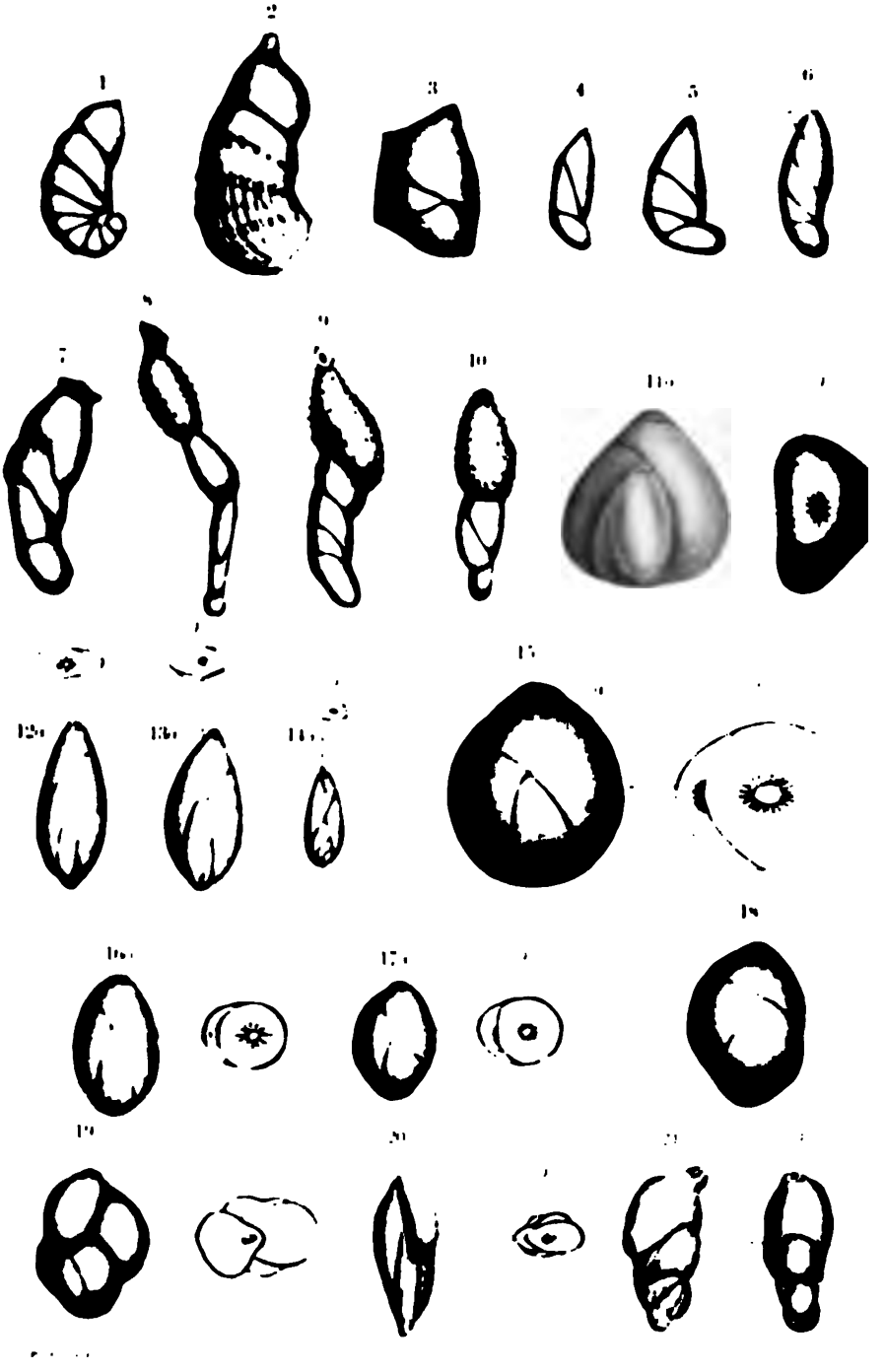

Foraminifera from the coast of the island of Delos.

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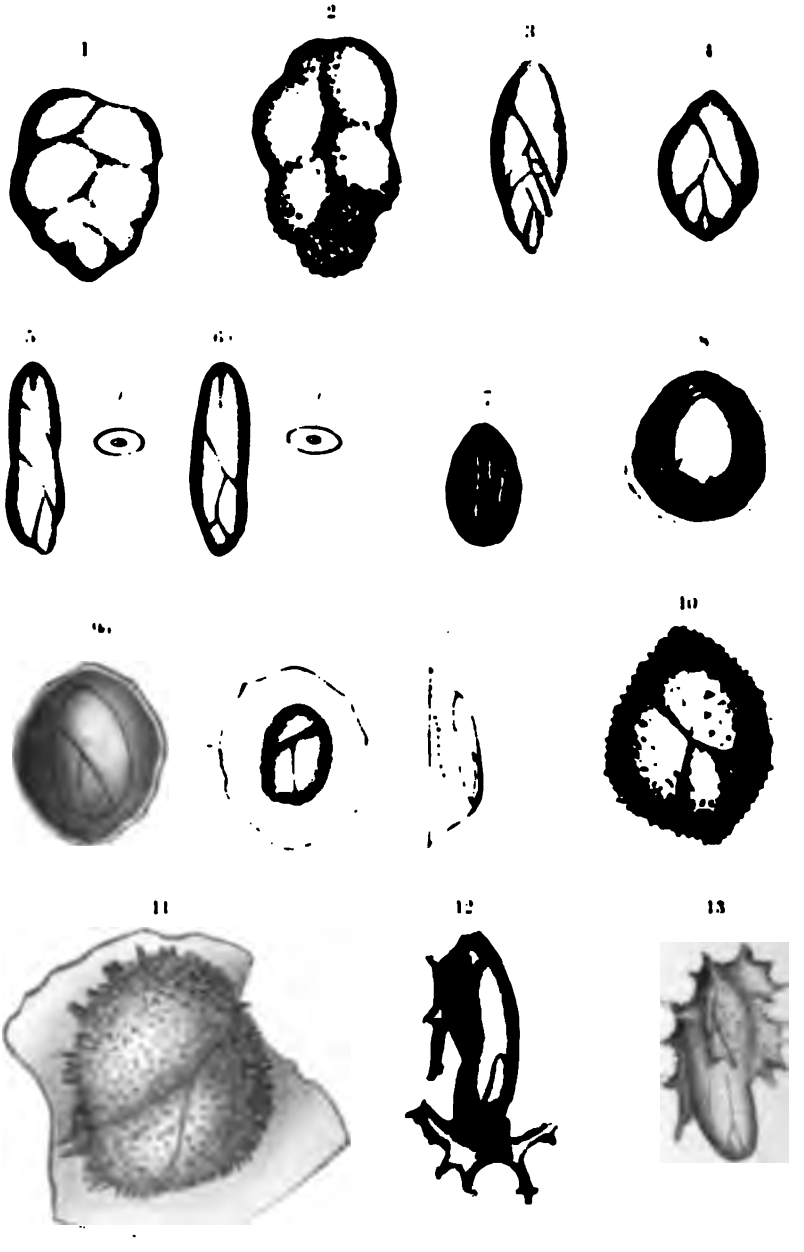

Foraminifera from the coast of the island of Delos.

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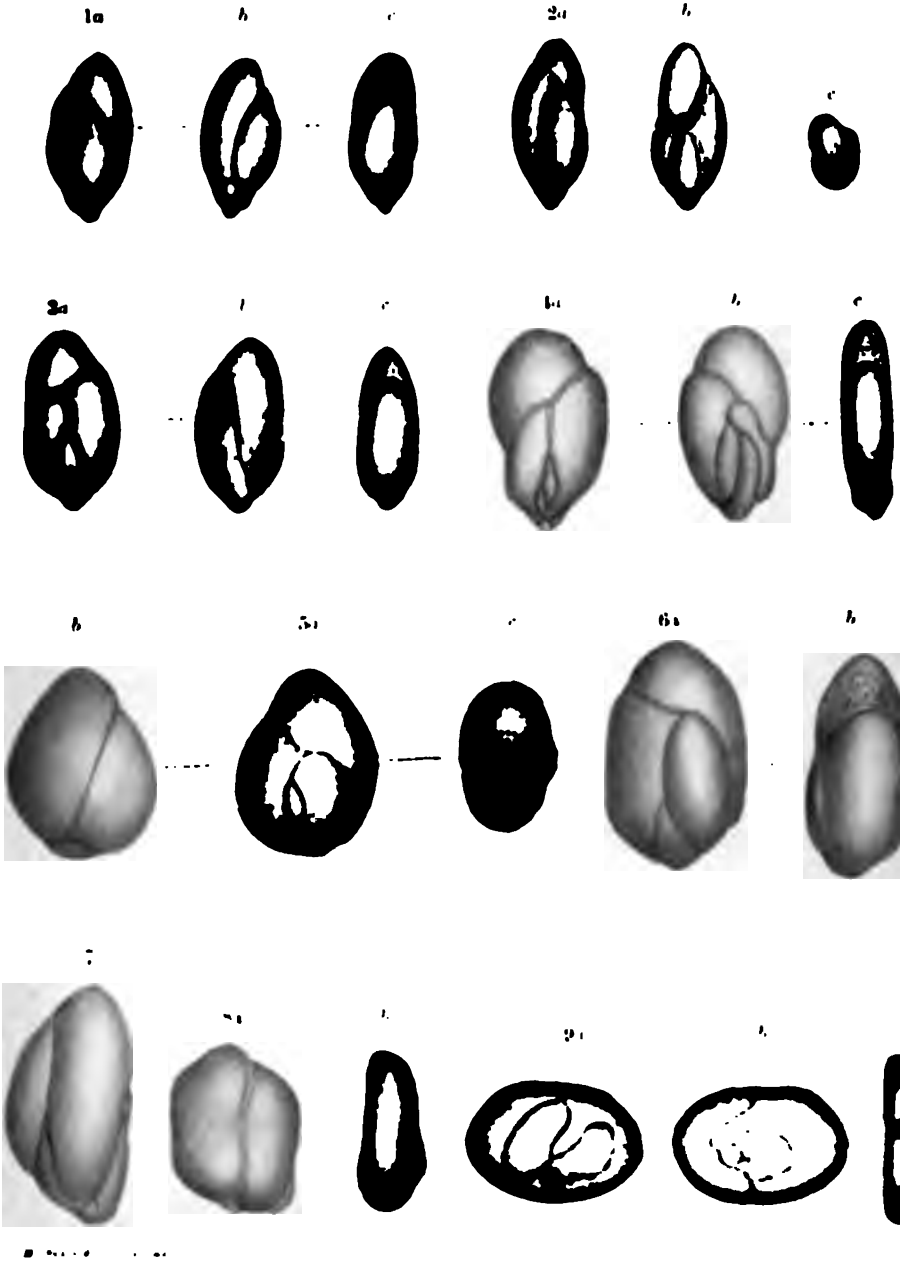


Foraminifera from the coast of the island of Delos.

Manchester Memoirs, Vol. li. (1907), *No.* 10.

X. On a collection of Birds from N.E. Rhodesia.

By S. A. NEAVE, M.A., B.Sc.,

Magdalen College, Oxford.

(*Communicated by Dr. W. E. Hoyle, F.R.S.E.*)

Received and read October 30th, 1906.

The following is a list of the birds collected by me during 1904 and 1905 in North Eastern Rhodesia, as naturalist to the Geodetic Survey. The locality proves extremely interesting as regards questions of geographical distribution. The localities may be divided into two main districts—(1) The Loangwa Valley and surrounding country, from 1,500 to 3,000 feet, which has mainly South African affinities, with a few Nyasa-land species added. (2) The high plateau between the Mchinga Escarpment and the upper reaches of the Kafue River. This country has an interesting fauna, with some West Coast and Equatorial Lake affinities.

The collection has been arranged according to Dr. Bowdler Sharpe's "Hand-List of Birds," with references to Dr. Reichenow's "Die Vögel Afrikas," and other standard works.

ORDER GALLIFORMES.

Family PHASIANIDÆ.

1. Francolinus shelleyi.

Francolinus shelleyi, Grant, *Ibis*, 1890, p. 348 (Natal, Matabeleland, and Swaziland); *Id.*, "Cat. B. Brit. Mus.," vol. 22, p. 157, pl. 6; Reichen., "Vög. Afrikas," vol. 1, p. 490. W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 208.

June 14th, 1907.

229. ♂ ad. Ulungu Mountain, W. Loangwa. June 11, 1905.

241. ♀ ad. Ulungu Mountain. June 15, 1905.

Bill, dark horn-colour, paler at base; *iris*, brown; *feet*, dull cream colour.

"Swembe" of the Asenga. Not uncommon in the thin bush in sandy country, and on the sides or tops of hills. Has a striking and distinct call.

2. **Francolinus natalensis.**

Francolinus natalensis, Smith, *S. Afr. Journ.*, vol. 2, p. 48 (1833, Natal); Grant, "Cat. B. Brit. Mus.," vol. 22, p. 166; Reichen., "Vög. Afrikas," vol. 1, p. 475 (1901); W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 212 (1906).

8. Immature. S. bank of Zambesi. June 21, 1904.

Bill, blackish, paler below; *iris*, brown; *feet*, blackish.

211. ♂ ad. E. bank of Loangwa. June 6, 1905.

228. ♂ ad. E. bank of Loangwa. June 8, 1905.

Bill, red, yellow at base; *iris*, brown; *feet*, orange red.

266. ♀ ad.? E. bank of Loangwa. June 24, 1905.

Bill, orange red, yellowish at base; *iris*, dark brown; *feet*, orange red.

280. ♂ ad. E. bank of Loangwa. June 28, 1905.

Bill, orange, greenish at base; *iris*, brown; *feet*, orange red.

289. ♀ ad. E. bank of Loangwa. June 30, 1905.

Bill, orange red, yellow at base; *iris*, brown; *feet*, orange red.

372. ♀ Immature. Near Petauke. August 16, 1905.

Bill, blackish above, pinkish-horn below; *iris*, brown; *feet*, orange brown, darker *toes*.

Native name, "Nkwali"; no special specific name.

Common in dense bush in the Loangwa Valley. This appears to be the first record of this species so far to the north.

3. Francolinus johnstoni.

Francolinus johnstoni, Shelley, *Ibis*, 1894, p. 24 (Zomba and Mlanje Hills); Grant, "Cat. B. Brit. Mus.," vol. 22, p. 559 (1893).

Francolinus hildebrandti johnstoni, Reichen., "Vög. Afrikas," vol. 1, p. 479 (1901).

127. ♂ ad. Petauke. March 29, 1905.

Bill, orange, yellow at base; *iris*, brown; *feet*, orange.

The only specimen met with of this Nyasa-land Francolin. "Nkwali," of the Asenga, but this is the generic name for all Francolins.

4. Pternistes melanogaster.

Pternistes nudicollis melanogaster, Neumann, *Journ. f. Ornith.*, vol. 46, 1898, p. 299, pl. 3, fig. 1 (Tanga, Usambara); Reichen., "Vög. Afrikas," vol. 1, p. 462.

Pternistes melanogaster, Sharpe, "Handl. B.," vol. 1, p. 25 (1899).

100. ♂ ad. Petauke. March 2, 1905.

Bill and *bare skin* of *face*, orange scarlet; *feet*, orange scarlet.

222. ♂ ad. E. bank of Loangwa. June 7, 1905.

275. ♂ ad. E. bank of Loangwa. June 26, 1905.

Bill and *bare skin* of *face*, scarlet; *iris*, brown; *feet*, scarlet.

297. ♀? ad. E. bank of Loangwa. July 4, 1905.

Bill, horn-tinted pink; *iris*, dark brown; *feet*, pinkish-red; *bare skin* on *face*, pinkish.

Native name, "Nkwali." Not uncommon in Loangwa Valley.

The species was described by Mr. Oscar Neumann from Usegua and Usambara in East Africa.

5. Pternistes cranchi.

Perdix cranchii, Leach, in Tuckey's "Narrat. Explor. River Zaire," App., p. 408. (1818: River Congo.)

Pternistes lucani, Bocage, "Orn. Angola," p. 402.

Pternistes cranchi, Grant, "Cat. B. Brit. Mus.," vol. 22, p. 178; Reichen., "Vög. Afrikas," vol. 1, p. 457.

399. ♂ ad. Road to Ndola, Alala Plateau. September 19, 1905.

410. ♂ ad. Road to Ndola, Alala Plateau. September 25, 1905.

452. ♂ ad. Bank of Kafue. October 19, 1905.

Bill, red, the tip horn-colour; *iris*, brown; *feet*, red; other *bare parts*, red.

"Insokosi" of the Alala.

Only met with on the high plateau west of the Mchinga Escarpment.

This would seem to be the most southern locality yet recorded for this species.

6. Pternistes swainsoni.

Perdix swainsoni, Smith, "Rep. Exp. Cent. Afr.," p. 54. (1836: Rivers South of Kurrichaine.)

Pternistes swainsoni, Grant, "Cat. B. Brit. Mus.," vol. 22, p. 179; Reichen., "Vög. Afrikas," vol. 1, p. 456; W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 217.

9. ♂ ad. Bank of Zambesi. June 21, 1904.

Bill, black, red at the base; *iris*, brown; *feet*, black.

135. ♀ ad. Bank of Loangwa. April 6, 1905.

Upper mandible, black, the *lower mandible*, red; *iris*, brown; *feet*, brownish-black; other *bare parts*, red.

157. ♂ ad. Bank of Loangwa. April 14, 1905.

Upper mandible, black, the *lower one*, red; *iris*, brown; *feet*, blackish, slightly tinted with red; other *bare parts*, red.

265. ♂ ad. E. bank of Loangwa. June 24, 1905.

Bill, dark horn; base of *upper* and whole of *lower mandible*, light red; *iris*, dark brown; *feet*, purplish-black.

"Chikwirikwiti" of the Asenga. Common; often snared by the natives in large numbers. *Bare skin* on *head* and *neck*, brilliant red in life.

Family NUMIDIDÆ.

7. Numida mitrata.

Numida mitrata, "Pall. Spic. Zool.," vol. 1, part 4, p. 18, pl. 3 (1767: Madagascar); Grant, "Cat. B. Brit. Mus.," vol. 22, p. 378; Reichen., "Vög. Afrikas," vol. 1, p. 438; W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 232.

549, 550. ♂ ♂ ad. Petauke. December 28, 1905.

Bill, pale horn, reddish at base; *iris*, olive-brown; *feet*, blackish; top and back of *head* and round *nostrils* crimson red; *casque* dusky-horn in colour; *orbits*, sides of *head* and *throat* pale blue mottled with darker blue; *lappets* pale blue, the distal half crimson red; *neck* blackish in dorsal line, rest pale blue with a large cobalt blue patch in midventral line.

Common everywhere in Loangwa Valley and to the east of it. It is doubtful if this species occurs on the Alala Plateau, west of the Mchinga range. If they occur at all there, they will not improbably be found on the southern and eastern borders. Toward the Kafue, this species appears to be replaced by *N. marungensis*. Usually in flocks of 10 to 15 individuals, which separate for pairing early in November. Occasionally seen in the

height of the dry season in very large flocks of from 100 to 200 individuals.

"Kanga" of all the neighbouring tribes.

8. Numida marungensis.

Numida marungensis. Schalow, *Zeitschr. gesamm. Orn.*, vol. 1, p. 105 (1884, Marungu); Reichen., "Vög. Afrikas," vol. 1, p. 443.

465. ♂ ad. E. bank of Kafue, near Ndola. October 24, 1905.

Bill, horn-colour, tips of *mandibles* paler; base of *lower mandible* reddish; *iris*, brown; *feet*, black; *bare skin* round *nostrils* and above *eyes* blood-red; *casque* and *back of head*, orange-yellow; around *eyes*, *ears*, side of *cheeks* and *throat* pale greenish-blue; *lappet*, purplish-blue, tipped red.

Two flocks only seen; both on the Kafue River. Appears to have the same habits as *N. mitrata.*

This appears to be the true *N. marungensis* of Schalow, being distinguished from the Benguela birds, *N. maxima* of Neumann, by its orange-yellow casque.

9. Guttera edouardi.

Numida edouardi, Hartl., *Journ. f. Ornith.*, 1867, p. 36 (Natal).
Numida cristata, Bocage, "Orn. Angola," p. 399.
Guttera edouardi, Grant, "Cat. B. Brit. Mus.," vol. 22, p. 382; W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 233 (1906).
Guttera cristata edouardi, Reichen., "Vög. Afrikas," vol. 1, p. 451.

305, 306. ♂ ♀ ad. E. bank of Loangwa. July 6, 1905.

Bill, horn-colour, greyish at base; *iris*, deep red; *feet*, dark grey in male, blue-grey in female; *bare skin* of

head and *neck* blackish, except the fold on the nape, which is a dirty white.

Native name, "Kangatori." Not uncommon, but local in Loangwa Valley. Frequents denser bush, and seems more independent of water than *N. mitrata*.

Order PTEROCLIDIFORMES.

Family Pteroclididæ.

10. Pterocles bicinctus.

Pterocles bicinctus, Temm., "Pig. et Gall.," vol. 3, pp. 247, 703; Bocage, "Orn. Angola," p. 395; Grant, "Cat. B. Brit. Mus.," vol. 22, p. 30; Reichen., "Vög. Afrikas," vol. 1, p. 309; W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 189.

137. ♂ ad. Near Petauke. April 8, 1905.

144. ♂ ad. Near Petauke. April 12, 1905.

Bill, yellowish-brown colour; *iris*, pale brown; *feet*, yellowish-brown; other *bare parts*, yellow.

290. ♂ ad. Bank of Loangwa. July 1, 1905.

Bill, orange yellow; *iris*, brown; *feet*, pale dull yellow; other *bare parts*, yellow.

"Chikwalakwala" of the Asenga. Not uncommon in "Mopani" flats and sandy areas near the big rivers. Nearly always in pairs. A South African species, now found for the first time to the north of the Zambesi.

Order COLUMBIFORMES.

Family Treronidæ.

11. Vinago wakefieldi.

Treron wakefieldi, Sharpe, *P.Z.S.*, 1873, p. 717, pl. 58, fig. 2 (Mombas).

Vinago wakefieldi, Salvad., "Cat. B. Brit. Mus.," vol. 21, p. 23: Shelley, *Ibis*, 1898, p. 381 (Mpala); Reichen, "Vög. Afrikas," vol. 1, p. 398.

22. ♀ ad. Mseizi river, Feira district. July 21, 1904.

113. ♀ ad. Petauke. March 20, 1905.

Bill, whitish, with a red base; *iris*, blue or bluish-red (22); *feet*, orange red.

Common everywhere. "Kombo Kombo" and "Mkuliti" of the Asenga. This is an East African species, which has been found on the Zambesi and Shire rivers.

12. **Vinago delalandei.**

Phalacrotreron delalandii, Bonap., "Consp. Av.," vol. 2, p. 6. (1854: Port Natal.)

Vinago delalandei, Salvad., "Cat. B. Brit. Mus.," vol. 21, p. 24; Shelley, *Ibis*, 1898, p. 381 (Zomba Plains), *Id.*, *Ibis*, 1901, p. 166 (Liwonde); Reichen., "Vög. Afrikas," vol. 1, p. 397.

Vinago delalandii, W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 157.

184. ♂ ad. Mbala Country. May 16, 1905.

185. ♂ ad. Mbala Country. May 18, 1905.

270. ♀ ad. E. bank of Loangwa. June 25, 1905.

Bill, whitish, red at the base; *iris*, blue; *feet*, in males, coral red, in females, orange red.

Not distinguished by the natives from *V. wakefieldi*.

Family PERISTERIDÆ.

13. **Turtur semitorquatus.**

Columba semitorquata, Rüpp., "Neue Wirbelth., Vög.," p. 66, pl. 23, fig. 2. (1835: Abyssinia.)

Turtur semitorquatus, Bocage, "Orn. Angola," p. 383; Salvad., "Cat. B. Brit. Mus.," vol. 21, p. 416; Shelley, *Ibis*, 1898, p. 555 (Zomba); Reichen., "Vög. Afrikas," vol. 1, p. 409; W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 167.

45. ♂ ad. Mezi River, Portuguese East Africa. September 23rd, 1904.

389. ♂ ad. Mlembo River. September 9, 1905.

440. ♀ ad. Ndola, Alala Plateau. October 12, 1905.

Bill, blackish ; *iris*, brown ; *feet*, dull purplish.

A common species. "Njiwa" of the Asenga.

14. Turtur damarensis.

Turtur damarensis, Finsch & Hartl., "Vög. Ostafr.," p. 550 (1870: Damara Land and Great Namaqua Land); Bocage, "Orn. Angola," p. 385; Salvad., "Cat. B. Brit. Mus.," vol. 21, p. 426 (Zomba).

Turtur capicola damarensis, Reichen., "Vög. Afrikas," vol. 1, p. 414; W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 171.

476. ♂ ad. Near Kapopo, Alala Plateau. October 29, 1905.

542. ♀ ad. Near Petauke. December 24, 1905.

Bill, dusky ; *iris*, brown ; *feet*, purplish-crimson.

A common species in the country. Native name, "Njiwa."

15. Turtur senegalensis.

Columba senegalensis, Linn., "Syst. Nat.," vol. 1, p. 283 (1766).

Turtur senegalensis, Bocage, "Orn. Angola," p. 388; Salvad., "Cat. B. Brit. Mus.," vol. 21, p. 448; Reichen., "Vög. Afrikas," vol. 1, p. 406; W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 172.

363. ♀ ad. Msanzara River, North of Petauke. August 5, 1905.

Bill, blackish ; *iris*, dark brown ; *feet*, purplish-lilac.

The only specimen met with. "Kapere" of the Asenga.

16. Oena capensis.

Columba capensis, Linn., "Syst. Nat.," vol. 1, p. 286 (1766).

Oena capensis, Bocage, "Orn. Angola," p. 392; Salvad., "Cat. B. Brit. Mus.," vol. 21, p. 501; Reichen., "Vög. Afrikas," vol. 1, p. 429; W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 174.

175. ♀ ad. Mbala Country, E. Loangwa district. May 9, 1905.

Bill, brownish-black; *iris*, brown; *feet*, purple red.

Fairly common; often in flocks. "Niakutundulu" of the Asenga.

17. Tympanistria tympanistria.

Columba tympanistria, Temm. and Knip., "Les Pigeons," vol. 1, p. 80, pl. 36. (1811.)

Peristera tympanistria, Bocage, "Orn. Angola," p. 393.

Tympanistria tympanistria, Salvad., "Cat. B. Brit. Mus.," vol. 21, p. 504; Shelley, *Ibis*, 1898, p 381 (Mount Mlosa and Mount Zomba); Reichen., "Vög. Afrikas," vol. 1, p. 424.

Tympanistria bicolor, W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 178.

243. ♂ ad. E. bank of Loangwa. June 17, 1905.

388. ♂ ad. Mlembo River. September 9, 1905.

Bill, dark purplish; *iris*, dark brown; *feet*, dark lilac.

A very scarce species compared with *C. chalcospilos*. Occasionally occurs amongst castor-oil plants in native gardens.

18. Chalcopelia chalcospilos.

Columba chalcospilos, Wagl., "Syst. Av., Columba," sp. 83 (1827).

Chalcopelia afra (*nec* Linn.); Bocage, "Orn. Angola," p. 389; Salvad., "Cat. B. Brit. Mus.," vol. 21, p, 506; Shelley, *Ibis*, 1898, p. 555 (Lake Shirwa); Reichen., "Vög. Afrikas," vol. 1, p. 426; W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 180.

Chalcopelia chalcospilos, Erlanger, *Orn. M.B.*, 1901, p. 183; Sharpe, *Bull. Brit. Orn. Club*, vol. 12, p. 83 (1902); Reichen., "Vög. Afrikas," vol. 3, Nachtrag, p. 811.

23. ad. Zambesi Valley, Feira district. July 25, 1904.

235. ♀ ad. Ulungu Mountain, W. Loangwa. June 13, 1905.

Bill, blackish; *iris*, dark brown; *feet*, purplish.

Common all over the country. Native name, "Niakutundulu."

ORDER RALLIFORMES.

Family RALLIDÆ.

19. Crex egregia.

Crex egregia, Peters, *Monatsb. k. Preuss. Akad. Berlin*, 1854, p. 134 (Mozambique); Reichen., "Vög. Afrikas," vol. 1, p. 278; W. L. Sclater, "Fauna S. Africa, Birds, vol. 4, p. 248.

Ortygometra egregia, Bocage, "Orn. Angola," p. 479.

Crecopsis egregia, Sharpe, "Cat. B. Brit. Mus.," vol. 23, p. 81.

139, 142. ♂ ♂ ad. Lichunio, near Petauke. April 11, 1905.

Bill, grey, black above in middle line, with amethyst base; *orbit*, orange red; *iris*, bright red; *feet*, olive brown.

"Sapata" of the Asenga. I did not meet with this elsewhere.

20. Limnocorax niger.

Rallus niger, Gm., "Syst. Nat.," vol. 1, p. 717 (1788: Cape of Good Hope and other parts of Africa).

Limnocorax niger, Bocage, "Orn. Angola," p. 481; Sharpe, "Cat. B. Brit. Mus.," vol. 23, p. 150; Shelley, *Ibis*, 1898, p. 381 (Lake Shirwa), *Id.*, *Ibis*, 1901, p. 167 (Karungwesi and Mbara); Reichen., "Vög. Afrikas," vol. 1, p. 279; W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 260.

10, 11. ♀ juv. Bank of Zambesi, Feira district. June 22, 1904.

172, 173. ♂ ♀ ad. Mbala Country. May 8, 1905.

Bill, sulphur yellow; *iris*, red.

298. ♂ imm. E. bank of Loangwa. July 4, 1905.

477. ♀ ad. Near Kapopo, N.W. Rhodesia. Sept. 29, 1905.

Not uncommon in long grass near rivers. Native name, "Nkukuruzi." Has a barking note like a leopard.

ORDER CHARADRIIFORMES.

Family CHARADRIIDÆ.

21. **Xiphidopterus albiceps.**

Vanellus albiceps, Gould, *P.Z.S.*, 1834, p. 45 (Fernando Po).

Xiphidopterus albiceps, Sharpe, "Cat. B. Brit. Mus.," vol. 24, p. 147; Reichen., "Vög. Afrikas," vol. 1, p. 192.

210. ♂ ad. Bank of Loangwa. June 5, 1905.

258. ♀ ad. Bank of Loangwa. June 22, 1905.

269. ♂ ad. Bank of Loangwa. June 25, 1905.

Bill, black and yellow; *iris*, pale greyish-green; *feet*, pale yellowish-green; *lappets*, yellow, but internal proximal half, black.

Native name, "Kankolinkoli." Common on sand-banks on the Loangwa. Has a harsh wailing cry.

This is by far the most southern record for this species.

22. **Oxyechus tricollaris.**

Charadrius tricollaris, Vieill., "N. Dict. d'Hist. Nat.," vol. 27, p. 147 (1818, Africa); Reichen., "Vög. Afrikas," vol. 1, p. 176.

Ægialitis tricollaris, Bocage, "Orn. Angola," p. 433: W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 367.

Oxyechus tricollaris, Sharpe, "Cat. B. Brit. Mus.," vol. 24, p. 247.

288. ♂ ad. E. bank of Loangwa. June 30, 1905.

307. ♂ ad. E. bank of Loangwa. July 7, 1905.

541. ♂ ad. Near Petauke. December 24, 1905.

Bill, black, pink base; *orbit*, scarlet; *iris*, brown; *feet*, flesh-colour, with dusky *toes*.

"Goma" of the Asenga. Common on sand-banks on the Loangwa.

23. Ægialitis tenellus.

Charadrius tenellus, Hartl., "Faun. Madag.," p. 72 (1861).

Ægialitis marginatus, Bocage (*nec.* Vieill.), "Orn. Angola," p. 433.

Ægialitis pallida (Strickl.), Sharpe, "Cat. B. Brit. Mus.," vol. 24, p. 284.

Charadrius marginatus tenellus, Reichen., "Vög. Afrikas," vol. 1, p. 171.

Ægialitis marginata pallida, W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 373.

207. ♂ ad. E. bank of Loangwa. June 4, 1905.

371. ♀ ad. E. bank of Loangwa. August 15, 1905.

♂ *Bill*, black; *iris*, brown; *feet*, whitish.

♀ *Bill*, blackish; *iris*, dark brown; *feet*, greyish-pink; blackish *toes*.

"Ndiondio" of the Asenga. Common on sand-banks on the Loangwa. The female was sitting on 3 eggs laid on the shingle.

The eggs of this species were found by Lieutenant Boyd Alexander near Chichowa, on the Zambesi. The two found by me measure as follows:—Axis, 1·2; diameter, ·9. The markings on these eggs are of a sepia-brown colour, and I do not see any of the reddish-brown described by Alexander.

24. Himantopus himantopus.

Charadrius himantopus, Linn., "Syst. Nat.," vol. 1, p. 255 (1766).

Himantopus autumnalis (Hasselq.): Bocage, "Orn. Angola," p. 470.

Himantopus himantopus, Sharpe, "Cat. B. Brit. Mus.," vol. 24, p. 310; Shelley, *Ibis*, 1898, p. 557 (Karonga); *Id.*, *Ibis*, 1901, p. 167 (Mbara and Lake Mweru); Reichen., "Vög. Afrikas," vol. 1, p. 207.

Himantopus candidus, Bonn.: W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 380.

272. ♂ ad. E. bank of Loangwa. June 25, 1905.

274. ♀ ad. E. bank of Loangwa. June 26, 1905.

Bill, black; *iris*, crimson red; *feet*, rose pink.

A pair, the only ones seen, were nesting on a sand-bank. Obtained by snaring. No nest was made, the eggs being merely laid in a hollow amongst the stones. Four eggs were found.

The male bird was remarkable for much greater length of leg than the female.

25. Glottis nebularius.

Scolopax nebularius, Gunner. in Leem, "Lapp. Beschr.," p. 251, (1767).

Totanus canescens (Gm.): Bocage, "Orn. Angola," p. 464.

Glottis nebularius, Sharpe, "Cat. B. Brit. Mus.," vol. 24, p. 481.

Totanus nebularis, Shelley, *Ibis*, 1898, p. 557 (Karonga).

Totanus littoreus (Linn.): Reichen., "Vög. Afrikas," vol. 1, p. 217.

Totanus glottis (Lath.): W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 392.

520. ♂ ad. E. bank of Loangwa. Nov. 26, 1905.

Bill, black; ventral surface of *mandible*, yellowish; *iris*, yellow; *feet*, orange yellow.

26. Rostratula capensis.

Scolopax capensis, Linn., "Syst. Nat.," vol. 1, p. 246 (1766).
Rhynchaea capensis, Bocage, "Orn. Angola," p. 476.
Rostratula capensis, Sharpe, "Cat. B. Brit. Mus.," vol. 24, p. 683; W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 418.
Rostratula bengalensis (Linn.): Reichen., "Vög. Afrikas," vol. 1, p. 237.

505. ♀ ad. Near Chiwali's, Alala Plateau. November 14, 1905.

Bill, olive-brownish, dark brown at tip; *iris*, olive-brown; *feet*, greyish-green.

The only specimen seen, though reported common from the Lukanga swamp and the shore of Lake Bangweolu.

Family PARRIDÆ.

27. Actophilus africanus.

Parra africana, Gm., "Syst. Nat.," vol. 1, p. 709 (1788); Bocage, "Orn. Angola," p. 477.
Phyllopezus africanus, Sharpe, "Cat. B. Brit. Mus.," vol. 24, p. 76; Shelley, *Ibis*, 1898, p. 556 (Lake Namaramba); *Id.*, *Ibis*, 1901, p. 167 (Karungwesi).
Actophilus africanus, Reichen., "Vög. Afrikas," vol. 1, p. 267; W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 338.

536. ♂ ad E. bank of Loangwa. December 21, 1905.

Bill and *frontal shield*, bluish-grey, tipped with greyish-horn; *iris*, dark brown; *feet*, slate.

Only met with on one particular pool near the Loangwa river. A common bird on the upper Shire river.

Family CURSORIIDÆ.

28. Rhinoptilus seebohmi.

Rhinoptilus seebohmi, Sharpe, *Bull. Brit. Orn. Club*, vol. 3, p. 13 (1893: Ondonga, Ovampo-land); *Id.*, "Cat. B. Brit. Mus.," vol. 24, p. 47, pl. 3, fig. 1; Reichen., "Vög. Afrikas," vol. 1, p. 161; W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 328.

Cursorius cinctus, Bocage (*nec* Heugl.), "Orn. Angola," p. 421.

138. ♀ ad. Lichunio, near Petauke. April 11, 1905.

373. ♂ ad. Lichunio, near Petauke. Aug. 18, 1905.

374. ♀ ad. Lichunio, near Petauke. Aug. 18, 1905.

Bill, black at the tip, yellow at the base; *orbit*, yellow; *iris*, brown; *feet*, dull whitish.

Common in one or two sandy localities in the Loangwa valley. Native name, "Gula." Has a remarkably harsh cry at night. This is a new locality for this species.

29. Rhinoptilus chalcopterus.

Cursorius chalcopterus, Temm., "Pl. Col.," vol. 5, pl. 298 (1824: Senegambia); Bocage, "Orn. Angola," p. 420.

Rhinoptilus chalcopterus, Sharpe, "Cat. B. Brit. Mus.," vol. 24, p. 48, pl. 4, fig. 1; Shelley, *Ibis*, 1898, p. 557 (Songwe); Reichen., "Vög. Afrikas," vol. 1, p. 157; W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 329.

5. ♀ ad. N. bank of Zambesi, Feira district. June 17, 1904.

Bill, black, red base; *iris*, dark brown; *feet*, red.

Not met with by me further north than the Zambesi.

Family ŒDICNEMIDÆ.

30. Œdicnemus vermiculatus.

Œdicnemus vermiculatus, Cab., *Journ. f. Ornith.*, 1868, p. 413; Bocage, "Orn. Angola," p. 423; Sharpe, "Cat. B. Brit. Mus.," vol. 24, p. 11; Shelley, *Ibis*, 1898, p. 557 (Likwenu); *Id.*, *Ibis*, 1901, p. 167 (Lake Mweru); Reichen., "Vög. Afrikas," vol. 1, p. 200; W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 318.

268. ♀ ad. Bank of Loangwa. June 24, 1905.
273. ♂ ad. Bank of Loangwa. June 25, 1905.
284. ? Bank of Loangwa. June 29, 1905.

Bill, black, yellow at base; *iris*, brownish-yellow, inwardly golden; *feet*, very pale greenish-yellow. The stomach of No. 284 contained two mice.

"Chintunia," of the Asenga. Considered a delicacy by the natives on account of its fat. Common on the Loangwa River.

Family OTIDIDÆ.

31. **Otis melanogaster.**

Otis melanogaster, Bocage (*nec* Rüpp.), "Orn. Angola," p. 417; Sharpe, "Cat. B. Brit. Mus.," vol. 23, p. 306 (part); Shelley, *Ibis*, 1898, p. 381 (Mount Mlosa and Zomba plains); Reichen., "Vög. Afrikas," vol. 1, p. 256; W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 302.

480. ♂ ad. Near Kapopo, N.W. Rhodesia. October 30, 1905.

Bill, yellowish-white, blackish above; *iris*, hazel brown; *feet*, pale yellowish.

One of the only pair of Bustards seen, though reported by natives of the Loangwa valley to occur there occasionally.

Native name, "Chisupasupa" of the Asenga, "Kasewa" of the Awisa, "Chindokowa" of the Alala.

ORDER ARDEIFORMES.

Family CICONIIDÆ.

32. **Pseudotantalus ibis.**

Tantalus ibis, Linn., "Syst. Nat.," vol. 1, p. 241 (1766); Bocage, "Orn. Angola," p. 454; Shelley, *Ibis*, 1898, p. 556 (Nyasaland); Reichen., "Vög. Afrikas," vol. 1, p. 333.

Pseudotantalus ibis, Sharpe, "Cat. B. Brit. Mus.," vol. 26, p. 327; W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 49.

538. ♀ ad. Bank of Loangwa. December 21, 1905.
539. ? Bank of Loangwa. December 21, 1905.

Bill, orange yellow; *bare skin* on *head*, crimson, on *throat* and *back of head*, orange; *iris*, dark brown; *legs*, pinkish; *tarsi*, flesh colour; *toes*, dusky.

Occasionally seen in flocks on the Loangwa River.

33. Ciconia nigra.

Ardea nigra, Linn., "Syst. Nat.," vol. 1, p. 235 (1766).

Ciconia nigra, Sharpe, "Cat. B. Brit. Mus.," vol. 26, p. 303; Reichen., "Vög. Afrikas," vol. 1, p. 346; W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 39.

201. ♂ juv. Niamadzi River, Loangwa Valley. June 1, 1905.

Bill, dull red; *bare skin* on *face* also red; *iris*, brown; *feet*, reddish-yellow.

Native name, "Matowankorno." One of a very large flock. This is a new locality for the species.

34. Leptoptilus crumeniferus.

Leptoptilus crumeniferus, Less., "Traité d'Orn.," p. 585 (1831: Senegal); Bocage, "Orn. Angola," p. 453; Sharpe, "Cat. B. Brit. Mus.," vol. 26, p. 319; Reichen., "Vög. Afrikas," vol. 1, p. 338; W. L. Sclater, Fauna S. Africa, Birds," vol. 4, p. 46.

548. ?♀. Near the Irumi Mountains, Alala Plateau, in captivity.

Bill and *feet*, dirty yellowish-white; *iris*, brown.

Native names, "Mkanga," "Namkulanchandwe."

Occasionally seen in large flocks on the Loangwa.

This individual was one of a pair obtained by natives from the nest, which was built in a patch of dense timber at the top of a tall tree.

Family SCOPIDÆ.

35. **Scopus umbretta.**

Scopus umbretta, Gm., "Syst. Nat.," vol. 1, p. 618 (1788); Bocage, "Orn. Angola," p. 457; Sharpe, "Cat. B. Brit. Mus.," vol. 26, p. 288; Reichen., "Vög. Afrikas," vol. 1, p. 353; W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 51.

1. ♂ ad. Near Feira. May 29, 1904.
296. ♀ ad. E. bank of Loangwa. July 3, 1905.

Bill, black; *iris*, brown; *feet*, black.

Common on all the rivers and streams. "Katawa" of all the local tribes. Natives have a great dislike to this bird, which they consider ill-omened.

Family ARDEIDAE.

36. **Nycticorax leuconotus.**

Ardea leuconotus, Wagl., "Syst. Av., Ardea," p. 189 (1827).
Nycticorax leuconotus, Bocage, "Orn. Angola," p. 450; Sharpe, "Cat. B. Brit. Mus.," vol. 26, p. 157; Reichen., "Vög. Afrikas," vol. 1, p. 363; W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 85.

295. ♀ juv. Bank of Loangwa. July 3, 1905.

Bill, black, with horn-coloured tips and yellow *nostrils* and base; *iris*, golden-yellow; *feet*, greenish-yellow; *bare skin* on *face* and *orbit*, yellow.

"Totwe," of the Asenga. This is an interesting new locality for the species, the nearest existing records appearing to be Benguela in Angola, and Rustenberg in the Transvaal.

37. **Butorides atricapilla.**

Ardea atricapilla, Afzel., *Acta Acad. Stockh.*, vol. 25, p. 264 (1804: Sierra Leone).

Butorides atricapillus, Bocage, "Orn. Angola," p. 446; Sharpe, "Cat. B. Brit. Mus.," vol. 26, p. 172; Shelley, *Ibis*, 1898, p. 556 (Mtondwe); Reichen., "Vög. Afrikas," vol. 1, p. 370; W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 370.

3. ♂ ad. Bank of Zambesi. June 16, 1904.
4. ♀ juv. Bank of Zambesi. June 16, 1904.
287. ♀ ad. Bank of Loangwa. June 30, 1905.
519. ♂ ad. Bank of Loangwa. November 26, 1905.

Bill, dusky yellow at base; *iris*, yellow; *legs* and *feet*, olive-brown and yellow. (519) *Iris*, blackish-brown; *feet* and *legs*, very pale greenish.

"Funkankosi" of most local tribes. Common on the big rivers.

38. Erythrocnus rufiventris.

Ardea rufiventris, Sundev., *Oefv. k. Vetensk.-Akad. Förh. Stockh.*, 1850, p. 110 (Caffraria); Bocage, "Orn. Angola," p. 441.

Erythrocnus rufiventris, Sharpe, "Cat. B. Brit. Mus.," vol. 26, p. 200; Reichen., "Vög. Afrikas," vol. 1, p. 370; W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 77.

537. ♂ ad. E. bank of Loangwa. December 21, 1905.

Base of *bill* and *orbit* greenish-yellow, tip blackish; *iris*, yellow; *feet*, yellowish.

This appears to be the first record of this species from north of the Zambesi, according to the localities given by Dr. Reichenow.

39. Ardeola ralloides.

Ardea ralloides, Scop., "Ann.," vol. 1, p. 88 (1769).

Ardeola comata (Pall.), Bocage, "Orn. Angola," p. 445.

Ardea ralloides (Sharpe), "Cat. B. Brit. Mus.," vol. 26, p. 202; Reichen., "Vög. Afrikas," vol. 1, p. 374; W. L. Sclater, "Fauna S. Africa, Birds," vol. 4. p. 75.

Herodias ralloides, Shelley, *Ibis*, 1898, p. 556 (Lake Shirwa).

7. ♂ ad. Bank of Zambesi. June 21, 1904.

Bill, black and grey, greenish-yellow at base; *iris*, yellow; *feet*, yellowish-green.

In flocks on the big rivers.

40. **Ardeirallus sturmi.**

Ardea sturmi, Wagl., "Syst. Av., Ardea," p. 191 (1827).

Botaurus sturmi, Bocage, "Orn. Angola," p. 447.

Ardeirallus sturmi, Sharpe, "Cat. B. Brit. Mus.," vol. 26, p. 244.

Ardetta sturmi, Reichen., "Vög. Afrikas," vol. 1, p. 368; W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 89.

50. ♂ ad. Petauke. December 1, 1904.

Bill, black, with the base olive; *iris*, red; *feet*, olive.

ORDER ANSERIFORMES.

Family ANATIDÆ.

41. **Alopochen ægyptiacus.**

Anser ægyptiacus, Briss., "Orn.," vol. 6, p. 284, pl. 27 (1760).

Chenalopex ægyptiacus, Bocage, "Orn. Angola," p. 497; Salvad., "Cat. B. Brit. Mus.," vol. 27, p. 167; Reichen., "Vög. Afrikas," vol. 1, p. 131.

Alopochen ægyptiacus, Sharpe, "Handl. B.," vol. 1, p. 215; W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 128.

540. ♀ ad. E. bank of Loangwa. Dec. 22, 1905.

Native name, "Kamba." Common on the Loangwa River and similar localities.

42. **Sarcidiornis melanonota.**

Anser melanonotus, Penn. in Forst., "Ind. Zool.," p. 21 (1781: Madagascar).

Sarcidiornis melanonota, Salvad., "Cat. B. Brit. Mus.," vol. 27, p. 54; Shelley, *Ibis*, 1898, p. 556 (Nyasaland); W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 119.

Sarkidiornis melanotus, Reichen., "Vög. Afrikas," vol. 1, p. 129.

Sarcidiornis africana, Eyton: Bocage, "Orn. Angola," p. 496.

179. ♀ ad. Mbala Country. May 12, 1905.

Bill, black ; *feet*, black.

"Chisipi" of the Asenga. Shot on a tree some 10 feet above a pond.

43. Dendrocygna fulva.

Dendrocygna fulva (Gm.): Bocage, "Orn. Angola," p. 500; Salvad., "Cat. B. Brit. Mus.," vol. 27, p. 149; Shelley, *Ibis*, 1898, p. 381 (Fort Johnston, Upper Shire); Reichen., "Vög. Afrikas," vol. 1, p. 126; W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 126.

463. ♂ ad. Bank of Kafue, near Ndola. Oct. 22, 1905.

Bill, dusky ; *iris*, brown ; *feet*, dusky grey.

"Mwilima" of the Alamba.

44. Nettium punctatum.

Anas punctata, Burchell, "Trav. Int. S. Africa," vol. 1, p. 283, note (1822: Zak River, Cape Colony); Reichen., "Vög. Afrikas," vol. 1, p. 120.

Querquedula hottentota, Smith ; Bocage, "Orn. Angola," p. 503.

Nettion punctatum, Salvad., "Cat. B. Brit. Mus.," vol. 27, p. 265 ; W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 139.

Nettium punctatum, Sharpe, "Handl. B.," vol. 1, p. 219 (1899).

367. ♂ ad. E. bank of Loangwa. August 12, 1905.

368. ♀ ad. E. bank of Loangwa. August 12, 1905.

450. ♂ ad. Kafulafuta River, N.W. Rhodesia. Oct. 17, 1905.

Bill, bluish-grey, blackish above, in middle line ; *iris*, brown ; *feet*, dusky grey.

"Mwidiri" of the Asenga, "Dipita" of the Achawa and Nyasa-land tribes.

ORDER PELECANIFORMES.

Family PHALACROCORACIDÆ.

45. **Phalacrocorax africanus.**

Pelicanus africanus, Gm., "Syst. Nat.," vol. 1, p. 577 (1788).
Graculus africanus, Bocage, "Orn. Angola," p. 522.
Phalacrocorax africanus, Shelley, *Ibis*, 1898, p. 556 (Lake Namaramba); Grant, "Cat. B. Brit. Mus.," vol. 26, p. 407; Reichen., "Vög. Afrikas," vol. 1, p. 93; W. L. Sclater, "Fauna S. Africa, Birds," vol. 4, p. 9.

26. ♀ ad. Bank of Loangwa, near Feira. August 9, 1904.

Bill, black; *iris*, red; *feet*, black.

ORDER ACCIPITRIFORMES.

Family FALCONIDÆ.

46. **Astur polyzonoides.**

Accipiter polyzonoides, Smith, "Ill. Zool. S. Africa, Aves," pl. 11 (1838: north of 26, S. Lat.).
Scelospizias polyzonoides, Bocage, "Orn. Angola," p. 19.
Astur polyzonoides, Shelley, *Ibis*, 1898, p. 381 (Mpimbi, Upper Shiré and Zomba Plains); Reichen., "Vög. Afrikas," vol. 1, p 556; W. L. Sclater, "Fauna. S. Africa, Birds," vol. 3, p. 358.

67. ♂ juv. Petauke. Jan. 26, 1905.

357. ♀ ad. Mterize River, Loangwa Valley. July 25, 1905.

521. ♂ ad. Petauke. December 5, 1905.

Bill, black, yellow at base; *cere*, yellow; *iris*, yellow (67), orange (357), or vermilion (521); *feet*, orange yellow.

Occurs commonly.

47. Accipiter ovampensis.

Accipiter ovampensis, Gurney, *Ibis*, 1875, p. 367, pl. 6 (Ovampo Land); Sharpe, "Handl. B.," vol. 1, p. 253; Reichen., "Vög. Afrikas," vol. 1, p. 560; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 352.

557. ♂ ad. Petauke. December 30, 1905.

Bill, black at tip, base and *cere* orange; *iris*, reddish-brown; *feet*, orange.

48. Accipiter minullus.

Falco minullus, Daud., "Traité," vol. 2, p. 88 (1800).

Accipiter minullus, Sharpe, "Cat. B. Brit. Mus.," vol. 1, p. 140; Bocage, "Orn. Angola," p. 20; Reichen., "Vög. Afrikas," vol. 1, p. 561; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 348.

111. ♂ ad. Petauke. March 17, 1905.

Bill, black; *cere*, yellow; *iris*, yellow; *feet*, greenish-yellow.

49. Asturinula monogrammica.

Falco monogrammicus, Temm., "Pl. Col.," vol. 1, pl. 314 (1824: Senegal).

Asturinula monogrammica, Sharpe, "Cat. B. Brit. Mus.," vol. 1, p. 275; Bocage, "Orn. Angola," p. 33; Shelley, *Ibis*, 1898, p. 381 (Zomba and Lakangula River), *Id.*, *Ibis*, 1901, p. 594 (Chanda); W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 327.

Kaupifalco monogrammicus, Reichen., "Vög. Afrikas," vol. 1, p. 547.

25. ♂ ad. Bank of Loangwa, Feira district. August 5, 1904.

353. ♀ ad. Mterize River, Loangwa Valley. July 25, 1905.

Bill, black at tip; *base of bill* and *cere*, red, or cinnamon brown (353); *iris*, red (25); *orbit*, narrow yellow; *feet*, red.

Native name, "Kaluangwe"; but this is a generic name for most of the smaller birds of prey.

50. **Helotarsus ecaudatus.**

Falco ecaudatus, Daud., "Traité," vol. 2, p. 54 (1800: Coast of Natal).

Helotarsus ecaudatus, Sharpe, "Cat. B. Brit. Mus.," vol. 1, p. 300; Bocage, "Orn. Angola," p. 41; Reichen., "Vög. Afrikas," vol. 1, p. 598; W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 314.

227. ♂? juv. E. bank of Loangwa. June 8, 1905.

Bill, yellowish, tip black; *iris*, brown; *feet*, yellowish, tinged with red.

Common everywhere, but difficult to shoot.

"Chipungu" of the Asenga and neighbouring tribes.

51. **Milvus ægyptius.**

Falco ægyptius, Gm., "Syst. Nat.," vol. 1, p. 261 (1788: Egypt).

Milvus ægyptius, Sharpe, "Cat. B. Brit. Mus.," vol. 1, p. 320; Bocage, "Orn. Angola," p. 43; Shelley, *Ibis*, 1898, p. 556 (Zomba); Reichen., "Vög. Afrikas," vol. 1, p. 609; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 336.

43. ♂. Mezi River, Portuguese East Africa. Sept. 18, 1904.

395. ♂. Road to Ndola, Alala Plateau, N.W. Rhodesia. Sept. 13, 1905.

406. ♂. Road to Ndola, Alala Plateau, N.W. Rhodesia. Sept. 24, 1905.

Bill, yellow; *iris*, brown; *feet*, yellow.

Common everywhere, especially during the winter months.

"Mwewe" of the Asenga.

51. Falco biarmicus.

Falco biarmicus, Temm., "Pl. Col.," vol. 1, pl. 324 (1825: Cape Colony); Sharpe, "Cat. B. Brit. Mus.," vol. 1, p. 391; Bocage, "Orn. Angola," p. 46; Shelley, *Ibis*, 1898, p. 381 (Mpimbi, Upper Shiré); Reichen., "Vög. Afrikas," vol. 1, p. 624; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 269, fig. 90.

507. ♂ ad. Near Chiwali's, Alala Plateau. Nov. 15, 1905.

Bill and *cere*, bluish-grey, with darker tips; *iris*, brown; *feet*, yellow.

Shot flying overhead, exactly like a Parrot. Stomach contained Orthoptera.

53. Falco subbuteo.

Falco subbuteo, Linn., "Syst. Nat.," vol. 1, p. 127 (1766); Sharpe, "Cat. B. Brit. Mus.," vol. 1, p. 395; Bocage, "Orn. Angola," p. 48; Reichen., "Vög. Afrikas," vol. 1, p. 628; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 272.

559, 560. ♂ ♀ ad. On the top of a mountain near Petauke. January 3, 1906.

Bill, bluish-dusky; *cere* and *orbit*, yellow; *iris*, dark brown; *feet*, yellow, *claws*, black.

Not previously met with.

54. Dissodectes dickinsoni.

Falco dickinsoni, Scl., *P.Z.S.*, 1864, p. 248 (Chibisa, River Shiré).

Cerchneis dickersoni, Sharpe, "Cat. B. Brit. Mus.," vol. 1, p. 447; Bocage, "Orn. Angola," p. 54.

Dissodectes dickinsoni, Sharpe, "Handl. B.," vol. 1, p. 278.

Cerchneis dickinsoni, Reichen., "Vög. Afrikas," vol. 1, p. 637.

Tinnunculus dickinsoni, W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 285.

30, ♀ ad. Bank of Loangwa, near Feira. Aug. 11, 1904.

Bill, black; *cere*, yellow; *iris*, dark reddish-brown; *feet*, yellow.

All Hawks of this size are known to the natives as "Kaluangu."

Order STRIGIFORMES.

Family Strigidæ.

55. **Strix flammea.**

Strix flammea, Linn., "Syst. Nat.," vol. 1, p. 133 (1766); Sharpe, "Cat. B. Brit. Mus.," vol. 2, p. 291; Bocage, "Orn. Angola," p. 63; Shelley, *Ibis*, 1898, p. 381 (Zomba Plains), p. 556 (Songwe); W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 337.

Strix flammea maculata, Brehm: Reichen., "Vög. Afrikas," vol. 1, p. 676.

186. ♀ ad. Mbala Country, E. Loangwa district. May 18, 1905.

313. ♀ ad. E. bank of Loangwa. July 8, 1905.

Bill, whitish; *iris*, brown; *feet*, greyish.

Native name "Manchichi." A bird of ill omen to the natives, as it is generally found in the "Msitu," or patches of dense forest such as most tribes select for their cemeteries.

Order PSITTACIFORMES.

Family Psittacidæ.

56. **Pœocephalus angolensis.**

Pionias fuscicollis (*nec* Kuhl.), Bocage, "Orn. Angola," p. 70.

Poicephalus robustus suahelicus, var. *angolensis*, Reichen., "Vög. Afrikas," vol. 2, p. 7.

202. ♀ ad. Niamadzi River, Loangwa Valley. June 1, 1905.

Bill, whitish ; *iris*, brown ; *feet*, grey.

Scarce and exceedingly wary.

"Chandwe" of the Asenga.

This bird seems to belong to the race which has been called *P. angolensis.*

57. Pœocephalus reichenowi.

Psittacus meyeri, Cretzschmaer in Rüpp., "Atlas," p. 18, pl. 11 (1826: Kordofan).

Pionias meyeri, Bocage, "Orn. Angola," p. 68.

Pœocephalus meyeri, Salvad., "Cat. B. Brit. Mus.," vol. 2c, p. 373; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 228.

Poicephalus meyeri reichenowi, Neum. ; Reichen., "Vög. Afrikas," vol. 2, p. 14.

16. ♂ juv. Mseizi River, Feira district. July 16, 1904.

177. ♂? Mbala Country, E. Loangwa district. May 11, 1905.

Bill, black (16), or greyish-black (177); *iris*, red (16), orange red (177) ; *feet*, black.

Common in pairs or small parties, but wary and difficult to procure.

"Chinkwe" of Nyasa tribes, "Chimfye" of the Asenga, "Chimpse" of the Chikunda.

58. Agapornis lilianæ.

Agapornis lilianæ, Shelley, *Ibis*, 1894, p. 466, pl. 12 (Fort Liwandi, Upper Shiré) ; Reichen., "Vög. Afrikas," vol. 2, p. 22 ; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 233.

217. ♂ ad. E. bank of Loangwa. June 6, 1905.

218—220. ♀ ad. E. bank of Loangwa. June 6, 1905.

254. ♂ ad. E. bank of Loangwa. June 19, 1905.

Bill, crimson, base whitish; *iris*, light brown; *feet*, grey; *orbit*, whitish.

Seen sparingly in flocks on the Loangwa.

"Cherenge" of the Asenga.

All these obtained in native gardens where the millet was being harvested.

The occurrence of this Nyasa-land species in the Loangwa Valley is decidedly interesting.

ORDER CORACIIFORMES.

Family CORACIIDÆ.

59. **Coracias caudatus.**

Coracias caudata, Linn., "Syst. Nat.," vol. 1, p. 160 (1766: Angola); Bocage, "Orn. Angola," p. 84.

Coracias caudatus, Sharpe, "Cat. B. Brit. Mus.," vol. 17, p. 21; Shelley, *Ibis*, 1898, p. 555 (Mwanza, Lake Shirwa, and Songwe), *Id.*, *Ibis*, 1901, p. 592 (Lindipe); Reichen., "Vög. Afrikas," vol. 2, p. 223; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 48.

27, 28. ♂ ♀ ad. W. bank of Loangwa, Feira district. August 11, 1904.

302. ♂ ad. E. bank of Loangwa. July 5, 1905.

Bill, black; *iris*, dull brown; *feet*, yellowish-brown.

Common in Loangwa Valley, but not seen west of the Mchinga Escarpment.

"Choli" of all the local tribes.

60. **Coracias spatulatus.**

Coracias spatulatus, Trimen, *P.Z.S.*, 1880, p. 31 (Tschobe, Zambesi); Sharpe, "Cat. B. Brit. Mus.," vol. 17, p. 22; Reichen., "Vög. Afrikas," vol. 2, p. 221; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 50.

114. ♂ ad. Petauke. March 23, 1905.

115. ♀ ad. Petauke. March 23, 1905.

141. ♂ juv. Lichunio, near Petauke. April 11, 1905.

Bill, black ; *iris*, brown ; *feet*, dull yellow. (141, *feet*, greenish-yellow.)

Sparingly in Loangwa Valley, not met with elsewhere. Stomach of one specimen contained Orthoptera.

61. Coracias olivaceiceps.

Coracias olivaceiceps, Sharpe, "Cat. B. Brit. Mus.," vol. 17, p. 25.

Coracias naevia, Bocage (*nec* Daud.), "Orn. Angola," p. 83.

Coracias mosambicus, Dresser ; Reichen., "Vög. Afrikas," vol. 2, p. 227 ; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 51.

13. ♀ ad. Mseize River, Feira district. July 11, 1904.

Bill, black ; *iris*, reddish-brown ; *feet*, yellow.

This seems to extend the range of this species a little further north than was previously known.

62. Eurystomus afer.

Coracias afra, Lath., "Ind. Orn.," vol. 1, p. 172 (1790 : Africa : described from specimen in British Museum).

Eurystomus afer, Bocage, "Orn. Angola," p. 85 ; Sharpe, "Cat. B. Brit. Mus.," vol. 17, p. 30 ; Shelley, *Ibis*, 1898, p. 555 (Nyasaland), *Id.*, *Ibis*, 1901, p. 592 (Angoniland : Chilasulo : Mpimbi) ; Reichen., "Vög. Afrikas," vol. 2, p. 228 ; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 54.

417. ♂ ad. Ndola, N.W. Rhodesia. Sept. 30, 1905.

453, 454. ♂ ♀ ad. Bank of Kafue, N.W. Rhodesia. Oct. 20, 1905.

Bill, yellow ; *iris*, brown ; *feet*, olive brown.

Only met with on or near the Kafue River, but also known to natives from the Angoni Plateau.

"Mkocho" of the Alamba, "Ifefe" of the Angoni.

Family ALCEDINIDÆ.

63. Ceryle rudis.

Alcedo rudis, Linn., "Syst. Nat.," vol. 1, p. 181 (1766).

Ceryle rudis, Bocage, "Orn. Angola," p. 97; Sharpe, "Cat. B. Brit. Mus.," vol. 17, p. 109; Reichen., "Vög. Afrikas," vol. 2, p. 295; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 73, figs. 26—28.

159. ♂ ad. Matambadzi River, Mbala Country. May 2, 1905.

370. ♀ ad. E. bank of Loangwa. Aug. 15, 1905.

Bill, black; *iris*, dark brown; *feet*, black.

"Tembo" of the Asenga.

Common on the big rivers.

64. Corythornis cyanostigma.

Alcedo cyanostigma, Rüpp., "Neue Wirb., Vög.," p. 70, pl. 24, fig. 2 (1835: Zana Lake, Abyssinia).

Corythornis cyanostigma, Bocage, "Orn. Angola," p. 96; Sharpe, "Cat. B. Brit. Mus.," vol. 17, p. 163; Reichen., "Vög. Afrikas," vol. 2, p. 289; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 81, fig. 30.

162. ♀ ad. Matambadzi River. May 4, 1905.

Bill, scarlet, blackish over nostrils; *iris*, dark brown; *feet*, dark red.

163, 164, 168. Young of 162.

The nest was dug out of the bank of the river.

Not very common, though widely distributed.

"Mlongwe" of the Asenga.

65. Halcyon swainsoni.

Halcyon pallidiventris, Cab., *Journ. f. Ornith.*, 1880, p. 349 (Angola); Bocage, "Orn. Angola," p. 538 (Talla Mogongo); Sharpe, "Cat. B. Brit. Mus.," vol. 17. p. 235: Shelley, *Ibis*, 1898, p. 555 (Tanganyika Plateau).

Halcyon swainsoni, Smith; Reichen., "Vög. Afrikas," vol. 2, p. 278; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 85.

427. ♀ ad. Ndola, N.W. Rhodesia. October 10, 1905.

472. ♀ ad. Near Kapopo, N.W. Rhodesia. October 27, 1905.

Bill, orange scarlet; *iris*, brown; *feet*, scarlet.

Only met with on the high plateau.

"Mlalapamo" of the Asenga.

66. **Halcyon orientalis.**

Halcyon orientalis, Peters, *Journ. f. Ornith.*, 1868, p. 134 (Inhambane); Sharpe, "Cat. B. Brit. Mus.," vol. 17, p. 238; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 89.

Halcyon albiventris orientalis, Reichen., "Vög. Afrikas," vol. 2, p. 275.

91. ♀ ad. Petauke. February 19, 1905.

117. ♀ ad. Petauke. March 24, 1905.

283. ♂ ad. E. bank of Loangwa. June 29, 1905.

Bill, red; *iris*, brown; *feet*, dark red.

This species and its allies are all known to the natives of the Loangwa Valley as "Sweswe."

67. **Halcyon chelicutensis.**

Alcedo chelicuti, Stanley in Salt's "Exped. Abyss.," App., p. lvi. (1834, Abyssinia).

Halcyon chelicutensis, Bocage, "Orn. Angola.," p. 101; Sharpe, "Cat. B. Brit. Mus.," vol. 17, p. 239; Shelley, *Ibis*, 1898, p. 380 (Mount Mlosa and Lakangula River).

Halcyon chelicuti, W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 89; Reichen., "Vög. Afrikas," vol. 2, p. 271.

52. ♂ ad. Petauke. December 11, 1904.

53. ♀ ad. Petauke. December 11, 1904.

♂ ***Maxilla***, black; ***mandible***, red; ***iris***, brown; ***feet***, reddish.

♀ ***Maxilla***, black; ***mandible***, faintly red; ***iris***, brown; ***feet***, reddish.

145. ♂ ad. Lichunio, near Petauke. April 12, 1905.

276. ♂ ad. E. bank of Loangwa. June 26, 1905.

Maxilla, black; ***mandible***, red; ***iris***, brown; ***feet***, dark red. Native name "Sweswe."

Family BUCEROTIDÆ.

68. **Bucorax caffer.**

Bucorax caffer, Bocage, *P.Z.S.*, 1873, p. 698, figs. 2, 5, and 6 (Mossamedes); *Id.*, "Orn. Angola," p. 111; Grant, "Cat. B. Brit. Mus.," vol. 17, p. 351; Reichen., "Vög. Afrikas," vol. 2, p. 236; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 102.

516. ♀ ad. Mchinga Mountains, W. of Loangwa. November 25, 1905.

Bill, black; ***bare skin*** on ***throat***, blue black, on ***head*** and ***neck***, brilliant scarlet; ***iris***, light brown; ***feet***, black.

517. ♂ ad. Mchinga Mountains, W. of Loangwa. November 25, 1905.

Bare skin on ***throat***, ***head***, and ***neck***, dull red, tinged with bluish, brighter on lower edge of throat and above eye.

Common, but very wary. The stomachs of these birds were full of snails, millipedes, termites, &c. They also undoubtedly eat tortoises. The natives have no special superstition about the bird, but do not consider it edible.

Native name "N͡gomba."

69. Lophoceros melanoleucus.

Buceros melanoleucus, Licht., "Cat. rer. nat. Hamb.," p. 8 (1793).

Lophoceros melanoleucus, Grant, "Cat. B. Brit. Mus.," vol. 17, p. 399; Shelley, *Ibis*, 1898, p. 380 (Zomba Plains); Reichen., "Vög. Afrikas," vol. 2, p. 249; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 110.

350. ♂ ad. Mterize River, Loangwa district. July 24, 1905.

359. ♀ ad. Mterize River, Loangwa district. July 26, 1905.

Bill, red, with a narrow line of yellowish-white at base; *iris*, ochre yellow; *feet*, black.

Common on the Zambesi, but scarcer to the north. It is a very wary species.

Native name "Niamlongwe."

70. Lophoceros neumanni.

Lophoceros neumanni, Reichen., "*Orn. Monatsb.*," 1894, p. 50 (Irangi); *Id. Journ. f. Ornith.*, 1894, p. 230 (Mgera); Sharpe, "Handl. B.," vol. 2, p. 67; Reichen., "Vög. Afrikas," vol. 2, p. 254.

98. ♀ Petauke. March 2, 1905.

Bill, dusky yellow at base, brownish-black at tip; *iris*, brown; *feet*, black.

"Niamlongo" or "Niamlongwe" of the Asenga.

Only previously recorded from German East Africa.

71. Lophoceros epirhinus.

Buceros epirhinus, Sundev., *Oefv. k. Vetensk.-Akad. Förh. Stockh.*, 1850, p. 108 (Upper Caffraria).

Lophoceros epirhinus, Grant, "Cat. B. Brit. Mus.," vol. 17, p. 408; Shelley, *Ibis*, 1898, p. 380 (Zomba Plains and Upper Shiré), p. 555 (Lake Shirwa and Likwenu R.); W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 114.

Tockus nasutus, Bocage (*nec* Linn.), "Orn. Angola," p. 408.
Lophoceros nasutus epirhinus, Reichen., "Vög. Afrikas," vol. 2, p. 258.

146. ♂ ad. Lichunio, near Petauke. April 12, 1905.

Bill, greyish-white; *mandible*, brownish-black; *iris*, red brown; *feet*, black.

Native name, "Niamlongo." Not uncommon.

72. Lophoceros erythrorhynchus.

Buceros erythrorhynchus, Temm., "Pl. Col.," vol. 2, gen. Buceros sp. 19 (1823: Sénégal et Guinée).
Tockus erythrorhynchus, Bocage, "Orn. Angola," p. 120.
Lophoceros erythrorhynchus, Grant, "Cat. B. Brit. Mus.," vol. 17, p. 409; Reichen., "Vög. Afrikas," vol. 2, p. 263; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 116.

12. ♂ ad. Bank of Zambesi. June 25, 1904.
143. ? Lichunio, near Petauke. April 12, 1905.
150. ♂ ad. Lichunio, near Petauke. April 13, 1905.
152. ♂ ad. Lichunio, near Petauke. April 14, 1905.
209. ♀ ad. Bank of Loangwa. June 5, 1905.
376. ♂ ad. Lichunio, near Petauke. August 19, 1905.

Maxilla, red; *mandible*, blackish, whitish at base; *iris*, ochre yellow, (143, 100) grey brown; *feet*, black.

This species of Horn-bill only occurs in the "Mopani" flats, near the big rivers.

"Kopi kopi" of the Asenga, in imitation of its cry.

73. Bycanistes buccinator.

Buceros bucinator, Temm., "Pl. Col.," vol. 2, part 48, pl. 284 (1824: Cape of Good Hope); Bocage, "Orn. Angola," p. 540.
Bycanistes buccinator, Grant, "Cat. B. Brit. Mus.," vol. 17, p. 421; Shelley, *Ibis*, 1898, p. 555 (Mwanza); Reichen., "Vög. Afrikas," vol. 2, p. 243; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 106.

469. ♂ ad. Near Kapopo, N.W. Rhodesia. October 26, 1905.

Bill and *casque*, black; *iris*, brown; *feet*, black.

Scarce, and exceedingly wary, but widely distributed. "N͡ga N͡ga" of most local tribes. Generally in pairs and usually on fruit trees.

Family UPUPIDÆ.

74. Upupa africana.

Upupa africana, Bechst., "Kürze Uebers.," p. 172 (1811: Congo); Bocage, "Orn. Angola," p. 124; Salvin, "Cat. B. Brit. Mus.," vol. 16, p. 14; Reichen., "Vög. Afrikas," vol. 2, p. 336; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 10.

56. ♂ ad. Petauke. December 19, 1904.

Bill, black; *feet*, dark brown.

Native name, "Papatali." Rather scarce, though widely distributed; generally occurs singly.

Family IRRISORIDÆ.

75. Irrisor erythrorhynchus.

Upupa erythrorhynchos, Lath., "Ind. Orn.," vol. 1, p. 280 (1790: Africa).

Irrisor erythrorhynchos, Reichen., "Vög. Afrikas," vol. 2, p. 338.

Irrisor viridis, Shelley (*nec* Licht.), *Ibis*, 1898, p. 555 (Mtondwe).

58. ♂ juv. Petauke. December 26, 1904. *Bill*, black.

188. ♀ ad. Mbala Country. May 18, 1905.

257. ♂ ad. E. bank of Loangwa. June 21, 1905.

312. ♂ ad. E. bank of Loangwa. July 8, 1905.

Bill, red; *iris*, brown; *feet*, red.

Common singly or in flocks. Freshly killed specimens have a strong and peculiar smell.

76. Rhinopomastus schalowi.

Rhinopomastus schalowi, Neum., *Journ. f. Ornith.*, 1900, p. 221.

Rhinopomastus cyanomelas schalowi, Reichen., "Vög. Afrikas," vol. 2, p. 347.

Rhinopomastus cyanomelas, Shelley (*nec* Vieill.), *Ibis*, 1898, p. 380 (Zomba Plains), p. 555 (Likwenu).

120. ♂ ad. Petauke. March 25, 1905.

176. ♀ juv. ? Mbala Country. May 9, 1905.

Bill, black ; *iris*, brown ; *feet*, black.

Not so common as the last species ; generally singly or in pairs ; but I have met with it in small flocks.

This species, as well as *I. erythrorhynchus*, is known to the Loangwa Valley people as "Tsegeleweni."

Family MEROPIDÆ.

77. Dicrocercus hirundineus.

Merops hirundineus, Licht., "Cat. rer. nat. rariss.," p. 21 (1793); Bocage, "Orn. Angola," p. 93.

Dicrocercus hirundineus, Sharpe, "Cat. B. Brit. Mus.," vol. 17, p. 43, pl. 1, fig. 1 ; Reichen., "Vög. Afrikas," vol. 2, p. 315 ; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 65.

233. ♂ ad. Ulungu Mountain. June 12, 1905.

Bill, black ; *iris*, red ; *feet*, grey.

Not observed elsewhere.

78. Melittophagus meridionalis.

Melittophagus meridionalis, Sharpe, "Cat. B. Brit. Mus.," vol. 17, p. 45, pl. 1, fig. 4 ; Shelley, *Ibis*, 1898, p. 555 (Mtondwe) ; Reichen., "Vög. Afrikas," vol. 2, p. 307 ; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3. p. 67.

Merops erythropterus, Bocage (*nec* Gm.), "Orn. Angola," p. 92.

154. ♀ ad. Petauke. April 18, 1905.

157. ♀ ad. Petauke. April 21, 1905.

282. ♂ ad. E. bank of Loangwa. June 29, 1905.

416. ♀ ad. Ndola, N.W. Rhodesia. September 30, 1905.

Bill, black ; *iris*, red ; *feet*, dusky.

Common everywhere, except during the height of the rains.

"Niandolansewe" of the Asenga, "Kalangombe" of the Achawa and Nyasa tribes.

I once watched one of these birds hawking Butterflies for more than half an hour. He always returned to the same perch. The majority of his captures consisted of *Hamanumida daedalus*, with one or two *Catopsilia florella*.

79. **Melittophagus albifrons.**

Spheconax albifrons, Cab. and Heine., "Mus. Hein.," vol. 2, p. 133 (1860 : South Africa).

Melittophagus albifrons, Sharpe, "Cat. B. Brit. Mus.," vol. 17, p. 53.

Merops bullockoides, Smith ; Bocage, "Orn. Angola," p. 93.

Melittophagus bullockoides, Shelley, *Ibis*, 1898, p. 555 (Lake Shirwa), *Id.*, *Ibis*, 1901, p. 592 (Chickala) ; Reichen., "Vög. Afrikas," vol. 2, p. 311 ; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 70.

291. ♀ ad. Bank of Loangwa. July 2, 1905.

292. ♂ ad. Bank of Loangwa. July 2, 1905.

535. ♂ ad. Bank of Loangwa. December 20, 1905.

Bill, black ; *iris*, brown ; *feet*, blackish.

In colonies on the sandy banks of the Loangwa.

80. **Merops apiaster.**

Merops apiaster, Linn., "Syst. Nat.," vol. 1, p. 182 (1766) ; Bocage, "Orn. Angola," p. 86 ; Sharpe, "Cat. B. Brit. Mus.," vol. 77, p. 63 ; Shelley, *Ibis*, 1898, p. 380 (Zomba Plains and Zomba), *Id.*, *Ibis*, 1901, p. 592 (Angoniland) ; Reichen., "Vög. Afrikas," vol. 2, p. 320 ; W. L. Sclater, "Fauna S. Africa, Birds," vol 3, p. 57.

413. ♂ ad. Road to Ndola, N.W. Rhodesia. September 28, 1905.

488. ♀ ad. Msofu River, Alala Plateau. November 7, 1905.

518. ♂ ad. Mountains W. of Loangwa. November 25, 1905.

Bill, black ; *iris*, blood-red ; *feet*, dusky.

Only observed on the higher plateau to the West. These specimens were probably on migration.

81. **Merops natalensis.**

Merops natalensis, Reichenb., "Handb., Merop.," p. 78, pl. 451 ; Sharpe, "Cat. B. Brit. Mus.," vol. 17, p. 84 ; Shelley, *Ibis*, 1898, p 555 (Zomba), *Id.*, *Ibis*, 1901, p. 592 (Angoniland).

Merops nubicus, Bocage (*nec* Gm.), "Orn. Angola," p. 90.

Merops nubicoides, Des Murs et Pucher. ; Reichen., "Vög. Afrikas," vol. 2, p. 328 ; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 62,

24. ♂ ad. W. bank of Loangwa, Feira district. August 3, 1904.

29. ♂ ad. W. bank of Loangwa, Feira district. August 11, 1904.

Bill, black ; *iris*, dark red ; *feet*, slate-colour.

Not uncommon, but local. Comes readily to grass fires.

"Makorikori" of all the neighbouring tribes.

Family CAPRIMULGIDÆ.

82. **Cosmetornis vexillarius.**

Semiophorus (Macrodypteryx?) vexillarius, Gould, "Icon. Av.," vol. 2, pl. 3 (1838).

Cosmetornis vexillarius, Bocage, "Orn. Angola," p. 155 ; Hartert, "Cat. B. Brit. Mus.," vol. 16, p. 595 ; Shelley, *Ibis*, 1898, p. 555 (Songwe, Nkata and Karonga) ; W. L. Sclater, "Fauna S. Africa, Birds,' vol. 3, p. 42.

Macrodypteryx vexillarius, Reichen., "Vög. Afrikas," vol. 2, p. 371.

441. ♂ ad. Ndola, N.W. Rhodesia. October 13, 1905. *Bill*, brownish, black at the tip; *iris*, brown; *feet*, chocolate brown.

Common all over the country.

"Lumbilumbi" of most local tribes.

83. **Caprimulgus fraenatus.**

Caprimulgus fraenatus, Salvad., *Ann. Mus. Genov.*, (2), vol. 1, p. 118 (1884: Daimbi, Shoa); Hartert, "Cat. B. Brit. Mus.," vol. 16, p. 533; Jackson, *Ibis*, 1902, p. 624 (Eldoma Ravine, Uganda); Reichen., "Vög. Afrikas," vol. 2, p. 357.

183. — ad. Mbala Country. May 16, 1905.

345. ♂ ad. Mterize River, Loangwa Valley. July 24, 1905.

511. ♀ ad. Near Chiwali's, Alala Plateau. November 16, 1905.

Bill, dark brown; *iris*, dark brown; *feet*, pale brownish.

Some eggs of this bird were picked up on the bare ground in open places. They are of the usual Night-jar type.

"Malwelwe" of the Asenga.

This is an East African species not previously recorded so far to the south.

Family COLIIDÆ.

84. **Colius affinis.**

Colius leucotis affinis, Shelley, *Ibis*, 1885, p. 312 (White Nile to Dar-es-Salaam); Reichen., "Vög. Afrikas," vol. 2, p. 205.

Colius affinis, Sharpe, "Cat. B. Brit. Mus.," vol. 17, p. 342, pl. 12, fig. 2; Shelley, *Ibis*, 1901, p. 592 (Angoniland).

433. ♂ ad. Ndola. October 11, 1905.

442. ♀ ad. Ndola. October 13, 1905.

Bill, black and whitish-horn-colour; *iris*, anterior two-thirds brown, posterior third yellowish-green; *feet*, crimson.

Common in flocks near the Kafue River; also seen occasionally on the banks of the Loangwa.

"*Ziazi*" of the Atonga and Nyasa tribes.

Order COCCYGES.

Family Musophagidæ.

85. **Turacus livingstonei.**

Turacus livingstonii, Gray, *P.Z.S.*, 1864, p. 44 (Manganja Highlands of East Africa, 3000 or 4000 ft.); Shelley, "Cat. B. Brit. Mus.," vol. 19, p. 439; *Id.*, *Ibis*, 1898, p. 380 (Mount Mlosa and Zomba Plains), p. 555 (Songwe); Reichen., "Vog. Afrikas," vol. 2, p. 51; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 216.

Corythaix livingstonii, Bocage, "Orn. Angola," p. 132.

48. ♂ ad. Mterize River. Nov. 2, 1904.

401. ♂ ad. Petauke. Nov. 19, 1904.

232. ♀ ad. E. bank of Loangwa. June 23, 1904.

Bill, dark red; *orbit*, orange; *eyelid*, whitish; *iris*, brown; *feet*, black.

"Nduwaluwa" of the Asenga, "Nkulukulu" of the Achawa and Nyasaland natives.

This bird in former days was considered to be Royal game, and its feathers could only be worn by chiefs.

It is snared by hanging the ripe orange fruit of a Cucurbitaceous plant up in the large trees mainly frequented by the birds. The fruit is hollowed out through an aperture of about an inch in diameter, in which a snare is placed.

86. Gallirex chlorochlamys.

Gallirex chlorochlamys, Shelley, *Ibis*, 1881, p. 118 (Ugogo and Dar-es-Salaam); *Id.*, "Cat. B. Brit. Mus.," vol. 19, p. 447; *Id.*, *Ibis*, 1898, p. 555 (Mtondwe); Reichen., "Vög. Afrikas," vol. 2, p. 40.

12. ♀ ad. Mseize River. July 8, 1904.
215. ♀ ad. E. bank of Loangwa. June 6, 1905.
259. ♂ ad. E. bank of Loangwa. June 22, 1905.
261. ♀ ad. E. bank of Loangwa. June 23, 1905.

Bill, black; *orbit*, dull red; *eyelid*, whitish; *iris*, brown; *feet*, black.

No. 12 seems slightly intermediate, and approaches *G. porphyrocephalus*.

Common in the denser bush in the Zambesi and Loangwa Valleys. Its cry is remarkably like that of a cock pheasant.

"Nduwa luwa" of the Asenga. This bird is good eating.

87. Musophaga rossæ.

Musophaga rossæ, Gould, *P.Z.S.*, 1858, p. 93 (Western Coast of Africa); Bocage, "Orn. Angola," p. 133; Shelley, "Cat. B. Brit. Mus.," vol. 19, p. 448; Reichen., "Vög. Afrikas," vol. 2, p. 29.

421. ♂ ad. Near Ndola, N.W. Rhodesia. Oct. 3, 1905.
424. ♀ ad. Near Ndola, N.W. Rhodesia. Oct. 4, 1905.
429. ♂ ad. Ndola, N.W. Rhodesia. Oct. 10, 1905.

Maxilla, brilliant yellow, shading to orange-red above the base in middle line. A dull reddish patch beneath each nostril; *mandible*, dull reddish, yellowish-horn at tip; *orbit*, bright yellow; *iris*, brown; *feet*, black.

Only found west of the Mchinga Escarpment, where

it was fairly common. Natives report it from the Luapula River. Crops of these birds invariably full of fruits and seeds.

"Nduwa" of the Alala and Awisa.

88. **Schizorhis concolor.**

Corythaix concolor, Smith, *S. Afr. Quart. Journ.*, 1833, p. 48 (25° 21′ S. lat.).

Schizorhis concolor, Bocage, "Orn. Angola," p. 134; Shelley, "Cat. B. Brit. Mus.," vol. 19, p. 453; *Id.*, *Ibis*, 1898, p. 380 (Zomba Plains), p. 555 (Mwanza); W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 219.

Chizaerhis concolor, Reichen., "Vög. Afrikas," vol. 2, p. 34.

181. ♂ ad. Mbala Country. May 14, 1905.

Bill, black; *iris*, brown; *feet*, black.

Not uncommon, but rather local, as it avoids hilly country. A somewhat wary bird.

"Kuwe" of the Asenga in imitation of its cry.

Family CUCULIDÆ.

89. **Coccystes glandarius.**

Cuculus glandarius, Linn., "Syst. Nat.," vol. 1, p. 167 (1766).

Coccystes glandarius, Bocage, "Orn. Angola," p. 145; Shelley, "Cat. B. Brit. Mus.," vol. 19, p. 212; *Id.*, *Ibis*, 1898, p. 380 (Zomba and Zomba Plains); Reichen, "Vög. Afrikas," vol. 2, p. 81; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 193.

533. ♂ ad. E. bank of Loangwa. Dec. 18, 1905.

Maxilla, black; *mandible*, dusky; *iris*, olive brown; *feet*, dusky.

This specimen was probably on migration, and it is not a little remarkable that this species, in common with *C. jacobinus* and *C. cafer*, should all have been obtained within a day or two of each other, and at the same place.

90. Coccystes jacobinus.

Cuculus jacobinus, Bodd., "Tabl. Pl. Enl." p. 53 (1783).

Coccystes jacobinus, Bocage, "Orn. Angola," p. 146; Shelley, "Cat. B. Brit. Mus." vol. 19, p. 217; Reichen., "Vög. Afrikas," vol. 2, p. 78; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 195.

532. ♂ ad. E. bank of Loangwa. Dec. 18, 1905.

Bill, black; *iris*, dark brown; *feet*, dusky.

"Kalembo" of the Asenga. These Cuckoos were apparently on migration.

91. Coccystes cafer.

Cuculus cafer, Licht., "Cat. rer. nat. Hamb.," p. 14 (1793).

Coccystes cafer, Shelley, "Cat. B. Brit. Mus.," vol. 19, p. 221; *Id.*, *Ibis*, 1898, p. 380 (Lakangula River, on the Zomba Plains), p. 555 (Mtondwe): Reichen., "Vög. Afrikas," vol. 2, p. 198; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 198.

Coccystes afer, Bocage, "Orn. Angola," p. 542.

534. ♂ ad. E. bank of Loangwa. Dec. 20, 1905.

Bill, black; *iris*, dark brown; *feet*, leaden.

Two or three pairs seen on this occasion for the first time.

92. Cuculus clamosus.

Cuculus clamosus, Lath., "Ind. Orn.," Suppl., p. 30 (1801: Cape of Good Hope): Bocage, "Orn. Angola," p. 141; Shelley, "Cat. B. Brit. Mus.," vol. 19, p. 260; Reichen., "Vög. Afrikas," vol. 2, p. 86; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 182.

78. ♀ juv. Molilo's, near Petauke. Feb. 4, 1905.

Bill, blackish-brown; *iris*, light brown; *feet*, greyish-brown.

93. Cuculus canorus.

Cuculus canorus, Linn., "Syst. Nat.," vol. 1, p. 168 (1766); Bocage, "Orn. Angola," p. 138; Shelley, "Cat. B. Brit. Mus.," vol. 19, p. 245; Reichen., "Vög. Afrikas," vol. 2, p. 89; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3. p. 177.

460. ♀ ad. Bank of Kafue. Oct. 21, 1905.

529. ♂ ad. Petauke. Dec. 9, 1905.

Maxilla, dusky; *mandible*, yellowish-brown, tipped with dusky; *iris*, yellow; *orbit*, yellow; *feet*, yellow.

94. Cuculus solitarius.

Cuculus solitarius, Stephens, "Gen. Zool.," vol. 9, p. 84, pl. 18 (1815: Caffraria and Madagascar); Shelley, "Cat. B. Brit. Mus.," vol. 19, p. 258; *Id.*, *Ibis*, 1898, p. 380 (Zomba); Reichen., "Vög. Afrikas," vol. 2, p. 87; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 178.

Cuculus capensis, Bocage (*nec* Müll.), "Orn. Angola," p. 140.

451. ♂ ad. Bank of Kafue, near Ndola. Oct. 19, 1905.

Maxilla, blackish; *mandible*, yellowish-horn, black at tip; *orbit*, yellow; *iris*, brown; *feet*, yellow.

"Mafutantowa" of the Asenga.

95. Metallococcyx smaragdineus.

Chalcites smaragdineus, Swains., "B. West Africa," vol. 2, p. 191 (1837: Gambia).

Chrysococcyx smaragdineus, Bocage, "Orn. Angola," p. 142; Shelley, "Cat. B. Brit. Mus.," vol. 19, p. 280; W. L Sclater, "Fauna S. Africa, Birds," vol. 3, p. 185.

Metallococcyx smaragdineus, Sharpe, "Handl. B.," vol. 2, p. 161; Reichen., "Vög. Afrikas," vol. 2, p. 101.

104. ♀ ad. Petauke. March 13, 1905.

Maxilla, black; *mandible*, pale blue; *orbit* pale blue; *iris*, brown; *feet*, greyish-blue.

Rather scarce in this country.

96. Chrysococcyx cupreus.

Cuculus cupreus, Bodd., "Tabl. Pl. Enl.," p. 40 (1783).

Chrysococcyx cupreus, Bocage, "Orn. Angola," p. 143; Shelley, "Cat. B. Brit. Mus.," vol. 19, p. 285; *Id.*, *Ibis*, 1898, p. 381 (Zomba Plains); Reichen., "Vög. Afrikas," vol. 2, p. 94; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 189.

455. Juv. Bank of Kafue, near Ndola. Oct. 20, 1905.

459. ♂ ad. Bank of Kafue. Oct. 21, 1905.

509. ♂ ad. Near Chiwali's. Nov. 15, 1905.

Bill, dusky, paler beneath; *iris*, red; *orbit*, scarlet; *feet*, dusky.

97. Centropus burchelli.

Centropus burchelli, Swains., "An. in Menag.," p. 321 (1838, South Africa); Shelley, *Ibis*, 1898, p. 555 (Karonga); Reichen., "Vög. Afrikas," vol. 2, p. 60; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 203.

Centropus senegalensis, Shelley, "Cat. B. Brit. Mus.," vol. 19, p. 360.

32. ♀ ad. Near Pakolwe Mountain, Portuguese East Africa. Aug. 25, 1904.

Bill, brownish-black.

223. ♀ ad. E. bank of Loangwa. June 7, 1905.

Bill, black; *iris*, red; *feet*, dark grey.

Common in long grass, in which it creeps about very rapidly, and seldom flies, making it hard to get a shot at. Said by natives to kill snakes, also cane-rats, by settling on their heads and picking out their eyes.

"Mkuta" of all the local tribes.

98. Centropus superciliosus.

Centropus superciliosus, Hempr. and Ehrenb., "Sym. Phys.," fol. r. (1828); Bocage, "Orn. Angola," p. 150; Shelley, "Cat. B. Brit. Mus.," vol. 19, p. 363; Reichen., "Vög. Afrikas," vol. 2, p. 65; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 208.

225. ♀ ad. E. bank of Loangwa. June 7, 1905.

Bill, black, shading to whitish at base of mandible; *iris*, red; *feet*, dark grey.

Its habits appear to be the same as those of *C. burchelli*.

Order SCANSORES.

Family Indicatoridæ.

99. Indicator indicator.

Cuculus indicator, Gm., "Syst. Nat.," vol. 1, p. 418 (1788: Interior of Africa).

Indicator indicator, Shelley, "Cat. B. Brit. Mus.," vol. 19, p. 5; Reichen., "Vög. Afrikas," vol. 2, p. 104.

Indicator sparrmanni, Stephens; Bocage, "Orn. Angola," p. 135; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 146.

34. ♂ juv. East of Loangwa, Portuguese East Africa. Sept. 7, 1904.

Bill, dark brown; *iris*, light brown; *feet*, black.

39. ♂ ad. East of Loangwa, Portuguese East Africa. Sept. 12, 1904.

Bill, greyish-purple; *iris*, brown; *feet*, brown.

174. ♂ ad. Mbala Country. May 8, 1905.

Bill, pale pink; *iris*, brown; *feet*, grey.

384. ♀ ad. West of Loangwa. Sept. 1, 1905.

Bill, dark brown; *iris*, brown; *feet*, dusky.

A common species in the country. Native name, "Msoro." Undoubtedly leads natives to honey.

416. ♀ ad. Ndola, N.W. Rhodesia. September 30, 1905.

Bill, black ; *iris*, red ; *feet*, dusky.

Common everywhere, except during the height of the rains.

"Niandolansewe" of the Asenga, "Kalangombe" of the Achawa and Nyasa tribes.

I once watched one of these birds hawking Butterflies for more than half an hour. He always returned to the same perch. The majority of his captures consisted of *Hamanumida daedalus*, with one or two *Catopsilia florella*.

79. **Melittophagus albifrons.**

Spheconax albifrons, Cab. and Heine., "Mus. Hein.," vol. 2, p. 133 (1860: South Africa).

Melittophagus albifrons, Sharpe, "Cat. B. Brit. Mus.," vol. 17, p. 53.

Merops bullockoides, Smith ; Bocage, "Orn. Angola," p. 93.

Melittophagus bullockoides, Shelley, *Ibis*, 1898, p. 555 (Lake Shirwa), *Id.*, *Ibis*, 1901, p. 592 (Chickala); Reichen., "Vög. Afrikas," vol. 2, p. 311 ; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 70.

291. ♀ ad. Bank of Loangwa. July 2, 1905.

292. ♂ ad. Bank of Loangwa. July 2, 1905.

535. ♂ ad. Bank of Loangwa. December 20, 1905.

Bill, black ; *iris*, brown ; *feet*, blackish.

In colonies on the sandy banks of the Loangwa.

80. **Merops apiaster.**

Merops apiaster, Linn., "Syst. Nat.," vol. 1, p. 182 (1766); Bocage, "Orn. Angola," p. 86 ; Sharpe, "Cat. B. Brit. Mus.," vol. 77, p. 63 ; Shelley, *Ibis*, 1898, p. 380 (Zomba Plains and Zomba), *Id.*, *Ibis*, 1901, p. 592 (Angoniland); Reichen., "Vög. Afrikas," vol. 2, p. 320 ; W. L. Sclater, "Fauna S. Africa, Birds," vol 3, p. 57.

408. ♀ ad. Road from Mkushi to Ndola, Alala Plateau. Sept. 25, 1905.

409. ♂ ad. Road from Mkushi to Ndola, Alala Plateau. Sept. 25, 1905.

Bill, white; *iris*, orange red; *feet*, pinkish-brown.

Only met with on the high plateau.

"Kamchonchola" of the Alala.

This bird has only been recorded from Nyasaland and the Tanganyika Plateau.

103. **Trachyphonus cafer.**

Picus cafer, Vieill., "N. Dict. d'Hist. Nat.," vol. 26, p. 102 (1818).

Trachyphonus cafer, Bocage, "Orn. Angola," p. 109; Shelley, "Cat. B. Brit. Mus.," vol, 19, p. 100; Reichen., "Vög. Afrikas," vol. 2, p. 154; W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 170.

134. ♀ ad. Lichunio, near Petauke. April 6, 1905.

Bill, yellow, blackish at the tip; *iris*, dark brown; *feet*, grey,

Native name, "Pupu." I found this a scarce bird in the Loangwa Valley.

Order PICIFORMES.

Family Picidæ.

104. **Dendromus fülleborni.**

Dendromus malherbei fülleborni, Neum., *Journ. f. Ornith.*, 1900, p. 204 (Lake Nyassa),

Dendromus fülleborni, Sharpe, *Ibis*, 1902, p. 639.

467. ♂ ad. Near Kapopo, N.W. Rhodesia. Oct. 25, 1905.

Bill, dusky, paler below; *iris*, reddish-brown; *feet*, greenish-grey.

Macrodypteryx vexillarius, Reichen., "Vög. Afrikas," vol. 2, p. 371.

441. ♂ ad. Ndola, N.W. Rhodesia. October 13, 1905. *Bill*, brownish, black at the tip; *iris*, brown; *feet*, chocolate brown.

Common all over the country.

"Lumbilumbi" of most local tribes.

83. **Caprimulgus fraenatus.**

Caprimulgus fraenatus, Salvad., *Ann. Mus. Genov.*, (2), vol. 1, p. 118 (1884: Daimbi, Shoa); Hartert, "Cat. B. Brit. Mus.," vol. 16, p. 533; Jackson, *Ibis*, 1902, p. 624 (Eldoma Ravine, Uganda); Reichen., "Vög. Afrikas," vol. 2, p. 357.

183. — ad. Mbala Country. May 16, 1905.

345. ♂ ad. Mterize River, Loangwa Valley. July 24, 1905.

511. ♀ ad. Near Chiwali's, Alala Plateau. November 16, 1905.

Bill, dark brown; *iris*, dark brown; *feet*, pale brownish.

Some eggs of this bird were picked up on the bare ground in open places. They are of the usual Night-jar type.

"Malwelwe" of the Asenga.

This is an East African species not previously recorded so far to the south.

Family COLIIDÆ.

84. **Colius affinis.**

Colius leucotis affinis, Shelley, *Ibis*, 1885, p. 312 (White Nile to Dar-es-Salaam); Reichen., "Vög. Afrikas," vol. 2, p. 205.

Colius affinis, Sharpe, "Cat. B. Brit. Mus.," vol. 17, p. 342, pl. 12, fig. 2; Shelley, *Ibis*, 1901, p. 592 (Angoniland).

Order PASSERIFORMES.

Family Hirundinidæ.

108. Chelidonaria urbica.

Hirundo urbica, Linn., "Syst. Nat.," vol. 1, p. 344 (1766).
Chelidon urbica, Sharpe, "Cat. B. Brit. Mus.," vol. 10, p. 87; W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 278.
Chelidonaria urbica, Sharpe, "Handl. B.," vol. 3, p. 187.
Delichon urbica, Reichen., "Vog. Afrikas," vol. 2, p. 431.

495, 497. ♂. South end of the Irumi Mountains, Alala Plateau. Nov. 11, 1905.

496, 498, 499. ♀. South end of the Irumi Mountains, Alala Plateau. Nov. 11, 1905.

Bill, black; *iris*, brown; *feet*, flesh-coloured, covered with white feathers.

A few out of many thousands, all assembled on a single tree, evidently on migration.

This is an interesting locality for this species, which has formerly only been recorded on two occasions from South Africa.

109. Hirundo griseopyga.

Hirundo griseopyga, Sundev., *Oefv. k. Vetensk.-Akad. Förh. Stockh.*, 1850, p. 107 (Port Natal); Sharpe, "Cat. B. Brit. Mus.," vol. 10, p. 152; Reichen., "Vog. Afrikas," vol. 2, p. 403; W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 297.

461, 462. ♀. Bank of Kafue. Oct. 22, 1905.

479. ♂. Near Kapopo, N.W. Rhodesia. Oct. 30, 1905.

Bill, dusky; *iris*, brown; *feet*, dusky.

"Kaminte" of the Asenga, "Kawaliwali" of the Manganja and Lake tribes.

Nests in the bank of the river. No. 479 was snared on its nest.

86. **Gallirex chlorochlamys.**

Gallirex chlorochlamys, Shelley, *Ibis*, 1881, p. 118 (Ugogo and Dar-es-Salaam); *Id.*, "Cat. B. Brit. Mus.," vol. 19, p. 447; *Id.*, *Ibis*, 1898, p. 555 (Mtondwe); Reichen., "Vög. Afrikas," vol. 2, p. 40.

12. ♀ ad. Mseize River. July 8, 1904.
215. ♀ ad. E. bank of Loangwa. June 6, 1905.
259. ♂ ad. E. bank of Loangwa. June 22, 1905.
261. ♀ ad. E. bank of Loangwa. June 23, 1905.

Bill, black; *orbit*, dull red; *eyelid*, whitish; *iris*, brown; *feet*, black.

No. 12 seems slightly intermediate, and approaches *G. porphyrocephalus*.

Common in the denser bush in the Zambesi and Loangwa Valleys. Its cry is remarkably like that of a cock pheasant.

"Nduwa luwa" of the Asenga. This bird is good eating.

87. **Musophaga rossæ.**

Musophaga rossæ, Gould, *P.Z.S.*, 1858, p. 93 (Western Coast of Africa); Bocage, "Orn. Angola," p. 133; Shelley, "Cat. B. Brit. Mus.," vol. 19, p. 448; Reichen., "Vög. Afrikas," vol. 2, p. 29.

421. ♂ ad. Near Ndola, N.W. Rhodesia. Oct. 3, 1905.
424. ♀ ad. Near Ndola, N.W. Rhodesia. Oct. 4, 1905.
429. ♂ ad. Ndola, N.W. Rhodesia. Oct. 10, 1905.

Maxilla, brilliant yellow, shading to orange-red above the base in middle line. A dull reddish patch beneath each nostril; *mandible*, dull reddish, yellowish-horn at tip; *orbit*, bright yellow; *iris*, brown; *feet*, black.

Only found west of the Mchinga Escarpment, where

113. Melaenornis ater.

Bradyornis ater, Sundev., *Oefv. k. Vetensk.-Akad. Förh. Stockh.*, 1850, p. 105 (Caffraria); Sharpe, "Cat. B. Brit. Mus.," vol. 3, p. 314; W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 234.

Melaenornis ater, Bocage, "Orn. Angola," p. 208; Reichen., "Vög. Afrikas," vol. 2, p. 443.

69. ♂ ad. Petauke. Feb. 2 1905.

70. ♀ ad. Petauke. Feb. 2, 1905.

158. ♂ ad. Petauke. April 21, 1905.

153. ? Molilo's, near Petauke. April 14, 1905.

Bill, black; *iris*, brown; *feet*, black.

114. Bradyornis murinus.

Bradyornis murinus, Finsch and Hartl., "Vög. Ostafr.," p. 866 (Caconda, Benguella); Sharpe, "Cat. B. Brit. Mus.," vol. 3, p. 310 note; Bocage, "Orn. Angola," p. 210; Shelley, *Ibis*, 1898, p. 380 (Zomba Plateau and Zomba); W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 239.

Bradyornis pallidus murinus, Reichen., "Vög. Afrikas," vol. 2, p. 436.

398. ♀ ad. Road to Ndola, N.W. Rhodesia. Sept. 17, 1905.

Bill, brownish-black; *iris*, dark brown; *feet*, black.

115. Muscicapa grisola.

Muscicapa grisola, Linn., "Syst. Nat.," vol. 1, p. 328 (1766); Sharpe, "Cat. B. Brit. Mus.," vol. 4, p. 151; Shelley, *Ibis*, 1898, p. 380 (Zomba); Reichen., "Vög. Afrikas," vol. 2, p. 449; W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 240.

Butalis grisola, Bocage, "Orn. Angola," p. 547.

506. ♂ ad. Road to Chiwali's, Alala Plateau. Nov. 14, 1905.

Bill, dusky, pale at base of lower mandible; *iris*, brown; *feet*, black.

524. ♂. Petauke. Dec. 6, 1905.

116. Muscicapa cærulescens.

Butalis cærulescens, Hartl., *Ibis*, 1865, p. 267 (Natal).

Muscicapa cærulescens, Sharpe, "Cat. B. Brit. Mus.," vol. 4, p. 154; Shelley, *Ibis*, 1898, p. 554 (Mtondwe); W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 241.

Muscicapa cinereola, Bocage, "Orn. Angola," p. 202.

Alseonax cærulescens, Reichen., "Vög. Afrikas," vol. 2, p. 454.

93. ♀ ad. Petauke. Feb. 22, 1905.

Bill, dark grey; *iris*, dark brown; *feet*, dark grey.

192. ♂ ad. Mterize River. May 24, 1905.

Bill, black (greyish below); *iris*, brown; *feet*, dark grey.

339. ♂ ad. Mterize River. July 23, 1905.

Bill, black (greyish below); *iris*, reddish-brown; *feet*, dark grey.

474. ♀ ad. Near Kapopo, N.W. Rhodesia. Oct. 27, 1905.

Iris, brown.

"Niamjeza" of the Asenga.

117. Batis molitor.

Muscicapa molitor, Hahn and Küster, "Vög. Asien, Africa, America, und Neuholland," part 20, pl. 3 (1836).

Batis molitor, Sharpe, "Cat. B. Brit. Mus.," vol. 4, p. 137; Bocage, "Orn. Angola," p. 198; Reichen., "Vög. Afrikas," vol. 2, p. 482.

180. ♂ ? ad. Mbala Country. May 13, 1905.

182. ♀ ad. Mbala Country. May 14, 1905.

278, 279. ♂ ad. E. bank of Loangwa. June 27, 1905.

501. ♀ ad. Road to Chiwali's, Alala Plateau. Nov. 13, 1905.

562, 563. ♂ ♀ ad. Near Petauke. Jan. 3, 1906.

Bill, black; *iris*, sulphur yellow, (278, 279) outwardly greenish, (501) whitish, (563) outwardly brown, inwardly whitish; *feet*, black.

Not uncommon in pairs and small parties throughout the country.

118. **Platystira jacksoni.**

Platystira jacksoni, Sharpe, *Ibis*, 1891, p. 445 (Sotik), 1892, p. 301, pl. 7, fig. 2; Reichen., "Vög. Afrikas," vol. 2, p. 488.

405. ♀ ad. Road to Ndola. Sept. 23, 1905.

Bill, black (*wattle* over eye, orange scarlet); *iris*, brown; *feet*, dusky.

The occurrence of this species so far south is not a little remarkable, the original specimens all coming from Equatorial Africa.

The female of this species seems to be hitherto undescribed. It differs from the male in having the throat and fore-neck black, with a little patch of white on the chin.

119. **Smithornis capensis.**

Platyrhynchus capensis, Smith, "Ill. Zool. S. Africa," pl. 27 (1839: South-east Coast towards Delagoa Bay).

Smithornis capensis, Sharpe, "Cat. B. Brit. Mus.," vol. 4, p. 388; Shelley, *Ibis*, 1898, p. 555 (Mtondwe and Fort Hill); Reichen., "Vög. Afrikas," vol. 2, p. 471; W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 248.

103. ♀ ad. Petauke. March 9, 1905.

190. ♂ ad. Mterize River. May 23, 1905.

314. ♂ ad. E. bank of Loangwa. July 9, 1905.

Bill, black above, white below; *iris*, brown; *feet*, greenish-yellow.

Not uncommon in the dense bush on the banks of streams.

"Tondowani" of the Asenga.

The nest and eggs (2) of this species were taken in the dense bush on the banks of a stream. They both closely agree with the description of S. African specimens given by Stark.

120. Erythrocercus livingstonei.

Erythrocercus livingstonii, Finsch and Hartl., "Vög. Ostafr.," p. 303 (1870: Zambesi); Sharpe, "Cat. B. Brit. Mus.," vol. 4, p. 298, pl. 9, fig. 2; Reichen., "Vög. Afrikas.," vol. 2, p. 495; W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 258.

358. ♂ ad. Mterize River, East Loangwa district. July 25, 1905.

Bill, pale brownish, whitish below; *iris*, dark brown; *feet*, pale brownish.

332. ♂ ad. Mterize River. July 19, 1905.

Bill, pinkish-brown; *iris*, light brown; *feet*, very pale brown.

Not met with elsewhere. "Katiti" of the Asenga.

121. Tchitrea plumbeiceps.

Terpsiphone plumbeiceps, Reichen. *in* Werth., "Mittl. Hochl. Deutsch-Ost-Afr.," p. 275 (1898).

Tchitrea plumbeiceps, Reichen., "Vög. Afrikas," vol. 2, p. 510.

Terpsiphone perspicillata, Shelley (*nec* Swains.), *Ibis*, 1898, p. 380 (Zomba).

51. ♂ ad. Petauke. Dec. 6, 1904.

63. ♀ ad. Petauke. Dec. 31, 1904.

422. ♂ ad. Near Ndola, N.W. Rhodesia. Oct. 4, 1905.

494. ♂ ad. Near Lusenfwa River. Nov. 10, 1905.

551. ♀ ad. Petauke. Dec. 29, 1905.

Bill, bright blue, tipped dusky; *orbit*, blue; *iris*, brown; *feet*, grey.

No. 494, one of two males which were fighting most viciously. This bird is curiously confused in the native mind with *Cossypha heuglini*, and is also called "Niam-tambwe."

122. Elminia albicauda.

Elminia albicauda, Bocage, "*Jorn. Acad. Lisb.*," vol. 6, no. 22, p. 159 (1877: Caconda); *Id.*, "Orn. Angola," p. 546; Shelley, *Ibis*, 1897, p. 543, 1899, p. 375; Reichen., "Vög. Afrikas," vol. 2, p. 497.

390. ♂ ad. Mchinga Escarpment, East edge of the Alala Plateau. Sept. 11, 1905.

391. ♀ ad. Mchinga Escarpment, East edge of the Alala Plateau. Sept. 11, 1905.

504. ♂ ad. Road to Chiwali's, Alala Plateau. Nov. 13, 1905.

Bill, black; *iris*, brown; *feet*, black.

Only met with on the high plateau, where it is by no means uncommon. It is a very tame but extraordinarily restless little bird.

Family CAMPOPHAGIDÆ.

123. Coracina pectoralis.

Graucalus pectoralis, Jard. & Selb., "Ill. Orn.," vol. 2, pl. 57 (1828: Sierra Leone); Sharpe, "Cat. B. Brit. Mus.," vol. 4, p. 29; Shelley, *Ibis*, 1898, p. 554 (Songwe); W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 274.

Ceblepyris pectoralis, Bocage, "Orn. Angola," p. 205.

Coracina pectoralis, Reichen., "Vög. Afrikas," vol. 2, p. 515.

106. ♀? juv. Petauke. March 15, 1905.

425. ♂ ad. Ndola, N.W. Rhodesia. Oct. 9, 1905.

Bill, black; *iris*, dark brown; *feet*, black.

124. Campophaga nigra.

Campophaga nigra, Vieill., "N. Dict. d'Hist.," vol. 10, p. 50 (1817), *ex* Levaill, pl. 165; Sharpe, "Cat. B. Brit. Mus.," vol. 4, p. 62; Bocage, "Orn. Angola," p. 206; Reichen., "Vög. Afrikas," vol. 2, p. 518; W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 269.

458. ♂. Bank of Kafue, near Kapopo. Oct. 21, 1905.
Bill, black, orange at gape; *iris*, brown; *feet*, black.

Family PYCNONOTIDÆ.

125. Andropadus oleaginus.

Andropadus oleaginus, Peters, *Journ. f. Ornith.*, 1868, p. 133 (Lourenzo Marques); Sharpe, "Cat. B. Brit. Mus.," vol. 6, p. 111 (Zambesi).

Chlorocichla oleagina, W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 70.

Andropadus insularis, Hartl.; Reichen., "Vög. Afrikas," vol. 3, p. 408.

44. ♀ ad. Bank of Mterize, Portuguese East Africa. Sept. 18, 1904.

212. ♀ ad. E. bank of Loangwa. June 6, 1905.
Bill, brownish-grey; *iris*, dark red; *feet*, grey.

277. ♂ ad. E. bank of Loangwa. June 26, 1905.
Bill, brownish-black; *iris*, dull red; *feet*, grey.

315. ♀ ad. E. bank of Loangwa. July 9, 1905.
Bill, greyish; *iris*, brownish-red; *feet*, grey.

448. ♀ ad. Kafulafuta River, N.W. Rhodesia. Oct. 17, 1905.
Bill, blackish; *iris*, red; *feet*, grey.

Common in the dense bush of the Loangwa Valley. Generally seen feeding among dry leaves on the ground.

"Chipalamaswaswa" of the Asenga.

126. Phyllostrophus strepitans.

Criniger strepitans, Reichen., *Ornith. Centralbl.*, 1879, p. 139 (Malindi, E. Africa).

Phyllostrophus strepitans, Sharpe, "Cat. B. Brit. Mus," vol. 6, p. 117; W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 72.

Phyllastrephus strepitans, Reichen., "Vög. Afrikas," vol. 3, p. 405.

191. ♀ ad. Mterize River. May 23, 1905.

Bill, black above, whitish below; *iris*, reddish-brown, *feet*, pinkish-grey.

281. ♂ ad. E. bank of Loangwa. June 28, 1905.

Bill, brownish, paler below; *iris*, pale brown; *feet*, grey.

316. ♀ ad. E. bank of Loangwa. July 9, 1905.

Bill, blackish-horn, paler below; *iris*, brown; *feet* greyish flesh-colour.

"Chipalamaswaswa" of the Asenga. Fairly common in the thick bush on the banks of streams.

127. Pycnonotus layardi.

Pycnonotus layardi, Gurney, *Ibis*, 1879, p. 390 (Rustenburg); Sharpe, "Cat. B. Brit. Mus.," vol. 6, p. 132; W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 63; Reichen., "Vög. Afrikas," vol. 3, p. 423.

Pycnonotus nigricans, Bocage (*nec* Vieill.), "Orn. Angola," p. 242.

2. ♀ ad. S. bank of Zambesi, near Feira. June 10, 1904.

Bill, black; *iris*, dark red; *feet*, black.

55. ♀ ad. Petauke. Dec. 16, 1904.

80. ♂ ad. Near Molilo's. Feb. 6, 1905.

Iris, brown.

119. ♀ ad. Petauke. March 25, 1905.
Iris, red brown.

355. ♂ ad. Mterize River. July 25, 1905.
Iris, dark reddish.

486. ♂ ad. Msofu River, Alala Plateau. Nov. 6. 1905.
Iris, dark brown.

491. ♀ ad. Lusenfwa River, Alala Plateau. Nov. 10, 1905.
Iris, dark brown.

Native name "Niapwiri." The commonest and most widely distributed bird in the country.

Family TIMELIIDÆ.

128. **Crateropus kirki.**

Crateropus kirki, Sharpe, ed. Layard's "B. S. Africa," p. 213, (1875: Zambesi Country); Bocage, "Orn. Angola," p. 250; Shelley, *Ibis*, 1898, p. 379 (Zomba), p. 554 (Likwenu, Palombe, and Songwe); Sharpe, "Handl. B.," vol. 4, p. 22; W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 57.

Crateropus jardinei kirki, Reichen., "Vög. Afrikas," vol. 3, p. 659.

147 ♀ ad. Near Petauke. April 12, 1905.
Bill, black; *iris*, orange, outwardly scarlet; *feet*, blackish.

293. ♂. Bank of Loangwa. July 2, 1905.
Bill, black; *iris*, orange, outwardly scarlet; *feet*, blackish.

Native name "Chikáiikáii." Not uncommon in small parties.

129. Crateropus hartlaubi.

Crateropus hartlaubi, Bocage, *Jorn. Acad. Lisb.*, vol. 2, p. 48 (1868: Huilla, Benguella); *Id.*, "Orn. Angola," p. 252, pl. 1, fig. 1; Sharpe, "Cat. B. Brit. Mus.," vol. 7, p. 478; W. L. Sclater, "Fauna S. Africa, Birds," vol. 2. p. 58; Reichen., "Vög. Afrikas," vol. 3, p. 663.

449. ♀ ad. Kafulafuta River, N.W. Rhodesia. Oct. 17, 1905.

Bill, black; *iris*, blood red; *feet*, greenish-horn-colour.

All the Babbling Thrushes are called "Chikâiikâii" by the natives.

Family TURDIDÆ.

130. Merula tropicalis.

Turdus tropicalis, Peters, *Journ. f. Ornith.*, 1881, p. 50 (Inhambane).

Turdus libonianus, Shelley (*nec* Smith), *Ibis*, 1898, p. 555 (Mtondwe, Chiradzula, and Fort Hill).

Merula tropicalis, Sharpe, "Handl. B.," vol. 4, p. 127.

Turdus libonyanus tropicalis, Reichen., "Vög. Afrikas," vol 3, p. 693.

148. ♀ ad. Lichunio, near Petauke. April 12, 1905.

Bill and *orbit*, orange; *iris*, brown?; *feet*, yellowish-brown.

558. ♀ juv. Near Petauke. Jan. 2, 1905.

Bill, horn-brown, orange yellow at gape; *iris*, dark brown; *feet*, pinkish flesh-colour.

"Ndiondio" of the Asenga. A bird seldom seen.

131. Petrophila angolensis.

Monticola angolensis, Sousa, *Jorn. Acad. Lisb.*, vol. 12, no. 48, pp. 225. 233 (1888: Quindumbo, Angola); W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 185; Reichen., "Vög. Afrikas," vol. 3, p. 698.

Petrophila angolensis, Sharpe, "Handl. B.," vol. 4, p. 145.
Monticola brevipes, Bocage (*nec* Strickl.), "Orn. Angola," p. 267.

231. ♂ ad. Ulungu Mountain, West Loangwa. June 12, 1905.

Bill, black; *iris*, brown?; *feet*, black.

Not met with elsewhere. On comparing this specimen with the series in the British Museum, I fail to see the slightest specific difference between *M. angolensis niassae* and the true *M. angolensis* of Sousa.

132. Cossypha bocagei.

Cossypha bocagii, Finsch and Hartl., "Vög. Ostafr.," p. 284, note (1870: Mossamedes); Bocage, "Orn. Angola," p. 259, pl. 2; Sharpe, "Cat. B. Brit. Mus.," vol. 7, p. 38.
Cossypha bocagei, Sharpe, "Handl. B.," vol. 4, p. 163; Reichen., "Vög. Afrikas," vol. 3, p. 755.

428. ♀ ad. Ndola, N.W. Rhodesia. Oct. 10, 1905.

Bill, black; *iris*, brown; *feet*, olive.

Habits similar to those of *C. heuglini*.

133. Cossypha heuglini.

Cossypha heuglini, Hartl., *Journ f. Ornith.*, 1866, p. 37 (Keren, Bogos Land); Sharpe, "Cat. B. Brit. Mus.," vol. 7, p. 41; Shelley, *Ibis*, 1898, p. 380 (Mount Mlosa and Zomba Plains), p. 554 (Mtondwe, Tanganyika Plateau and Lake Shirwa); W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 211; Reichen., "Vög. Afrikas," vol. 3, p. 758.

300. ♀ ad. E. bank of Loangwa. July 5, 1905.
360. ♂ ad. Mterize River. July 26, 1905.
478. ♂ ad. Near Kapopo. Oct. 29, 1905.

Bill, black; *iris*, brown; *feet* (300), greyish-horn-colour; (360) dark brownish; (478) greyish-brown.

Common, but hard to find in the "Marusaka" or dense dry jungle on the flats near the bigger rivers.

Native name, "Niamtambwe." Has a singularly sweet song.

134. Cossypha barbata.

Cossypha barbata, Finsch and Hartl., "Vög. Ostafr.," p. 864 (1870: Benguella); Bocage, "Orn. Angola," p. 260, pl. 2; Sharpe, "Cat. B. Brit. Mus.," vol. 7, p. 43.

Erythropygia barbata, Reichen., "Vög. Afrikas," vol. 3, p. 769.

411. ♀ ad. On the road to Ndola, N.W. Rhodesia. Sept. 26, 1905.

Bill, blackish, paler below; *iris*, brown; *feet*, flesh.

This bird was captured on its nest, which was made in a hole in a tree. The eggs, three in number, were very hard set, and were broken in catching the bird. Eggs pale greenish, marked with chocolate, especially towards the broader end.

135. Erythropygia zambesiana.

Erythropygia zambesiana, Sharpe, *P.Z.S.*, 1882, p. 588, pl. 14, fig. 2 (Tete, Zambesi); *Id.*, "Cat. B. Brit. Mus.," vol. 7, p. 78, pl. 15, fig. 1; W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 224; Reichen., "Vög. Afrikas," vol. 3, p. 775.

A. = 14. ♂ ad. Mseizi River, Feira district. July 13, 1904.

Bill, black, base, yellow; *iris*, black; *feet*, pinkish-horn-colour.

136. Thamnolæa shelleyi.

Saxicola shelleyi, Sharpe, ed. Layard's "B. S. Africa," p. 246 (1877: Victoria Falls).

Thamnolæa shelleyi, Sharpe, "Cat. B. Brit. Mus.," vol. 7, p. 52; *Id.*, "Handl. B.," vol. 4, p. 170.

Thamnolæa arnotti (Tristr.); W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 208.

Myrmecocichla nigra (Vieill.); Reichen, "Vög. Afrikas," vol. 3., p. 706.

237. ♂ ad. Ulungu Mountain, West Loangwa. June 13, 1905.

238. ♀ ad. Ulungu Mountain, West Loangwa. June 13, 1905.

457. ♀ ad. Bank of Kafue. Oct. 21, 1905.

464. juv. Bank of Kafue. Oct. 23, 1905.

Prefers a somewhat open type of country at 3,000 feet or over, with scattered but large timber. Has curious creeping habits on tree trunks, now and then behaving like a fly-catcher.

137. **Pratincola torquata.**

Muscicapa torquata, Linn., "Syst. Nat.," vol. 1, p. 328; (1766: Cape of Good Hope).

Pratincola torquata, Sharpe, "Cat. B. Brit. Mus.," vol. 4, p. 190; Bocage, "Orn. Angola," p. 274; Shelley, *Ibis*, 1898, p. 554 (Kasungu and Zomba); W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 190; Reichen., "Vög. Afrikas," vol. 3, p. 732.

170. ♂. Mbala Country. May 7, 1905.

510. ♀. On the road to Chiwali's, Alala Plateau. Nov. 16, 1905.

Bill, black (170) or horn-brown (510); *iris*, brown; *feet*, black.

Seen occasionally in long grass in the more open country. Native name, "Niamchenchi."

138. **Saxicola falkensteini.**

Saxicola falkensteini, Cab., *Journ. f. Ornith.*, 1875, p. 235 (Loango); Sharpe, "Handl. B.," vol. 4, p. 175; W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 202.

Saxicola galtoni, Bocage (*nec* Strickl.), "Orn. Angola," p. 271.

Phœnicurus familiaris falkensteini, Reichen., "Vög. Afrikas," vol. 3, p. 783.

230. ♂? Ulungu Mountain, West Loangwa. June 11, 1905.

414. ♂ ad. Ndola, N.W. Rhodesia. Sept. 30, 1905.

415. ♀ ad. Ndola, N.W. Rhodesia. Sept. 30, 1905.

Bill, blackish; *iris*, brown; *feet*, blackish.

139. **Campicola pileata.**

Motacilla pileata, Gm., "Syst. Nat.," vol. 1, p. 965 (1788: Cape of Good Hope).

Saxicola pileata, Seebohm, "Cat. B. Brit. Mus.," vol. 5, p. 397; Bocage, "Orn. Angola," p. 272; W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 196; Reichen., "Vög. Afrikas," vol. 3, p. 718.

Campicola pileata, Sharpe, "Handl. B.," vol. 4, p. 180.

Saxicola livingstonii (Tristr.); Shelley, *Ibis*, 1898, p. 554 (Palombe and Songwe).

309. ♂ ad. Bank of Loangwa. July 7, 1905.

324. ♂ ad. Mterize River. July 15, 1905.

468. ♀ ad. Near Kapopo, N.W. Rhodesia. Oct. 26, 1905.

489. ♂ ad. Msofu River, Alala Plateau. Nov. 7, 1905.

Bill, black; *iris*, brown; *feet*, black.

Somewhat local. Resembles a Wagtail in its habits.

Family SYLVIIDÆ.

140. **Cisticola stoehri**, n. sp.

Similis *C. angusticaudæ*, sed rostro longiore, notæo brunneo haud cinerascente distinguenda, pileo ferrugineo dorso haud concolori.

C. stoehri culmen, 10 mm.

C. angusticauda culmen, 8 mm.

These specimens might have been expected to be *C. melanure*, Cab., but the tail is brown, not black, and is much shorter. The tail-feathers also have pale tips, and a dusky-blackish subterminal spot, but the light ends are not very pronounced. A further difference is the rufous-brown back. These differences are constant in all the four specimens obtained.

I have much pleasure in dedicating this species to Dr. F. O. Stoehr, medical officer to the expedition.

20, 21. ♂ ad. Mseize River, Feira district. July 19, 1904.

Bill, brownish-pink ; *iris*, red ; *feet*, pink.

245. ♀ ad. *Type.* E. bank of Loangwa. June 18, 1905.

Bill, pinkish, base blackish above ; *iris*, light brown ; *feet*, pale pink.

351. ♂ ad. *Type.* Mterize River. July 24, 1905.

Bill, pinkish-brown, paler below ; *iris*, yellowish-brown ; *feet*, pale pinkish.

141. Cisticola rufopileata.

Cisticola rufopileata, Reichen., *Journ. f. Ornith.*, 1891, p. 69 ; *Id.*, "Vög. Afrikas," vol. 3, p. 561.

492. ♂ ad. Near the Lusenfwa River, Alala Plateau. Nov. 10, 1905.

Bill, dusky-horn, paler below ; *iris*, yellowish-brown ; *feet*, pale brownish colour.

142. Cisticola sylvia.

Cisticola sylvia, Reichen., *Orn. Monatsb.*, vol. 12, p. 28 (1904 : Ulegga, Central Africa) : *Id.*, "Vög. Afrikas," vol. 3, p. 563.

213. ♂ ad. E. bank of Loangwa. June 6, 1905.

Bill, dark brown, paler below ; *iris*, light brown ; *feet*, pinkish-brown.

It was very interesting to find this species in the Loangwa Valley, as it has hitherto only been recorded from the Equatorial Lake District.

143. **Sylvia simplex.**

Sylvia simplex, Lath., "Gen. Syn.," Suppl., vol. 1, p. 287 (1787); Shelley, *Ibis*, 1898, p. 554 (Nkata); W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 82; Sharpe, "Handl. B.," vol. 4, p. 209; Reichen., "Vög. Afrikas," vol. 3, p. 649.

Sylvia hortensis, Bechst.; Seebohm, "Cat. B. Brit. Mus.," vol. 5, p. 10; Bocage, "Orn. Angola," p. 284.

Sylvia hortensis (*simplex*) Shelley, *Ibis*, 1898, p. 380 (Mount Mlosa and Zomba Plateau).

438. ♀ ad. Ndola, N.W. Rhodesia. Oct. 12, 1905.

Bill, brownish-horn-colour, paler below; *iris*, brown; *feet*, silvery-grey.

484. ♀ ad. Near the Msofu River, Alala Plateau. Nov. 5, 1905.

Bill, dusky-horn-colour, paler below; *iris*, brown; *feet*, pale greyish.

144. **Apalis florisuga.**

Euprinodes florisuga, Reichen., *Journ. f. Ornith.*, 1898, p. 314 *ex* Licht. Mus. Berol.

Apalis florisuga, Reichen., "Vög. Afrikas," vol. 3, p. 610.

Chlorodyta flavida (part), W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 125.

253 ♂ ad. E. bank of Loangwa. June 19, 1905.

Bill, blackish; *iris* and *orbit*, chestnut brown; *feet*, pinkish-yellow colour.

310. ♀ ad. E. bank of Loangwa. July 7, 1905.

Bill, greyish, tip blackish; *iris*, yellowish-brown; *feet*, pinkish-brown; *tarsi*, darker.

Native name, "Niatiantia." According to Dr. Reichenow (key) these birds are *A. florisuga* Reich. If so, it is an entirely new locality for that species. Further, I am rather inclined to think that Dr. Reichenow is right in suggesting that *A. neglecta* is also the same species.

145. Eremomela polioxantha.

Eremomela polioxantha, Sharpe, "Cat. B. Brit. Mus.," vol. 7, p. 160 (1883 : Swazi Land) ; W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 108 ; Reichen., "Vög. Afrikas," vol. 3, p. 636.

Eremomela polioxanthis, Shelley, *Ibis*, 1899, p. 373 (Tanganyika Plateau).

161. ♂ juv. Matambadzi River, Mbala Country. May 3, 1905.

Bill, pinkish-grey ; *iris*, red brown ; *feet*, dark grey.

146. Eremomela pulchra.

Tricholais pulchra, Bocage, *Jorn. Acad. Lisb.*, vol. 6, no. 24, pp. 257, 275 (1878 : Caconda) ; *Id.*, "Orn. Angola," p. 555.

Eremomela pulchra, Sharpe, "Cat. B. Brit. Mus.," vol. 7, p. 162 ; Reichen., "Vög. Afrikas," vol. 3, p. 640.

160. ♂ ad. Matambadzi River, Mbala Country. May 3, 1905.

Bill, black ; *iris*, pale yellow ; *orbit*, chocolate ; *feet*, yellowish-brown.

435. ♂ ad. Ndola, N.W. Rhodesia. Oct. 11, 1905.

Bill, black ; *iris*, outwardly brown, inwardly yellow ; *feet*, pale brownish.

502. ♀ ad. Near Chiwali's, Alala Plateau. Nov. 13, 1905.

Bill, brownish-horn-colour ; *iris*, brown ; *feet*, yellowish-horn-colour ; *tarsi*, dusky.

There is a young bird of this species in the National Collection, from Caconda, Angola. It appears to be a very doubtfully distinct species from *E. citriniceps*.

147. **Camaroptera sundevalli.**

Camaroptera sundevalli, Sharpe, *Journ. f. Ornith.*, 1882, p. 347, (South Africa); *Id.*, "Cat. B. Brit. Mus.," vol. 7, p. 169; W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 113.

Camaroptera griseoviridis sundevalli, Reichen, "Vög. Afrikas," vol. 3, p 618

Camaroptera brevicaudata, Bocage (*nec* Rüpp.), "Orn. Angola," p. 280.

301. ♂ ad. E. bank of Loangwa. July 5, 1905.

Bill, blackish, grey at base of lower *mandible*; *iris*, orange brown; *feet*, pinkish-brown.

This appears to be the first recorded occurrence of this species from north of the Zambesi.

148. **Camaroptera griseoviridis.**

Orthotomus griseo-viridis, Mull., "Naum.," vol. 1, part 4, p. 27. (1851: Cordofan).

Camaroptera brevicaudata, Bocage (*nec* Cretzschm.), "Orn. Angola," p. 280: Sharpe, "Cat. B. Brit. Mus.," vol. 7, p. 168. W. L. Sclater, "Fauna S. Africa, Birds," vol. 3, p. 114.

Camaroptera griseoviridis, Reichen., "Vög. Afrikas," vol. 3, p. 616.

81. ♂ ad. Molilo's, near Petauke. Feb. 7, 1905.

Bill, black; *iris*, reddish-brown; *feet*, pink.

125. ♂ ad. Petauke March 27, 1905.

Bill, black; *iris*, reddish-brown; *feet*, pinkish-brown.

522. ♂ ad. Petauke. Dec. 5, 1905.

Bill, black; *iris* and *orbit*, reddish-brown; *feet*, pinkish-brown.

525. ♂ ad. Petauke. Dec. 8, 1905.

Bill, black; *iris* and *orbit*, yellowish-brown; *feet*, pinkish-brown.

In common with all the Reed Warblers, this species is known to the natives as "Niatiye."

149. **Prinia mystacea.**

Prinia mistacea, Rüpp., "Neue Wirbelth., Vög.," p. 110 (1835-1840: Gondar).

Drymoica affinis, Bocage, "Orn. Angola," p. 552.

Prinia mystacea, Sharpe, "Cat. B. Brit. Mus.," vol. 7, p. 191; W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 135; Reichen., "Vög. Afrikas," vol. 3, p. 590.

87. ♀ ad. Petauke. Feb. 10, 1905.

171. ♀ ad. Mbala Country. May 7, 1905.

561. ♂ ad. Near Petauke. Jan. 3, 1906.

Bill, black (in the ♀ pinkish at base); *iris* and *orbit*, golden brown; *feet*, pinkish-brown.

All the small Warblers are known to the natives as "Niatiye."

Family PRIONOPIDÆ.

150. **Prionops talacoma.**

Prionops talacoma, Smith, "Rep. Expl. Exped.," app. 45 (1836: South Africa, 25° S. Lat.); Sharpe, "Cat. B. Brit. Mus.," vol. 3, p. 321; Bocage, "Orn. Angola," p. 221; Shelley, *Ibis*, 1898, p. 379 (Zomba), p. 554 (Mwanza); W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 51; Reichen., "Vög. Afrikas," vol. 2, p. 528.

60. ♀ ad. Petauke. Dec. 29, 1904.

Bill, black; *iris*, olive-brown; *feet*, orange.

65. ♂ ad. Petauke. Jan. 3, 1905.

Bill, black; *iris*, bright yellow; *feet*, orange-red.

66. ♀ ad.

122. ♀ ad. Petauke. March 27, 1905.

Bill, black ; *iris*, brownish-yellow ; *feet*, orange ; *orbit*, brighter yellow in female than male, but yellow *iris* of male markedly brighter than that of female.

123. ♂ ad. Petauke. March 27, 1905.

Bill, black ; *iris*, yellow ; *feet*, orange.

Native name "Ngombeweniweni." In flocks in the hilly country.

I found this bird (No. 122) making a very pretty little nest of fibre and dry grass ; the outside entirely covered with white cobwebs, which gave it quite a silvery appearance. There were several nests in a little clump of trees, and it is evident that the bird breeds in colonies.

The eggs were four in number, and are of a pale bluish-stone-colour, with spots and dots of reddish- and purplish-brown, and with underlying larger spots of purplish-grey.

The eggs measure, axis from ·8 to ·85 ; diameter, ·6.

This appears to be the first record of the nest and eggs of this species.

151. Sigmodus tricolor.

Prionops tricolor, Gray, *Ann. Mag. Nat. Hist.* (3), vol. 14, p. 379 (1864 : Tete, Zambesi).

Sigmodus tricolor, Sharpe, "Cat. B. Brit. Mus.," vol. 3, p. 325 ; Shelley, *Ibis*, 1898, p. 379 (Zomba and Zomba Plains), p. 554 (Chiradzula) ; W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 50.

Sigmodus retzii tricolor, Reichen., "Vög. Afrikas," vol. 2, p. 535.

59. ♂ ad. Petauke. Dec. 29, 1904.

Bill, yellow, the base red ; *iris*, orange ; *feet*, orange.

94. ♀ ad. Petauke. Feb. 23, 1905.

Bill, red, shading to yellow at tip ; *iris*, yellow ; *feet*, salmon-red.

126. ♀ ad. Petauke. March 27, 1905.

Bill, red, the tip orange; *iris*, yellow; *feet*, coral-red; the *orbit* scarlet in all specimens.

Family LANIIDÆ.

152. Lanius minor.

Lanius minor, Gm., "Syst. Nat.," vol. 1, p. 308 (1788); Bocage, "Orn. Angola," p. 214; Gadow, "Cat. B. Brit. Mus.," vol. 8, p. 235; W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 11; Reichen., "Vög. Afrikas," vol. 2, p. 616.

490. ♀. On the Lusenfwa River, Alala Plateau. Nov. 10, 1905.

Bill, greyish at horn, blackish at tip; *iris*, brown; *feet*, blackish.

153. Enneoctonus collurio.

Lanius collurio, Linn., "Syst. Nat.," vol. 1, p. 136 (1766); Gadow, "Cat. B. Brit. Mus.," vol. 8, p. 286; W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 11; Reichen., "Vög. Afrikas," vol. 2, p. 622.

Enneoctonus collurio, Bocage, "Orn. Angola," p. 215; Shelley, *Ibis*, 1898, p. 379 (Mount Mlosa, Mount Zomba and Zomba Plains).

508. ♀ ad. Road to Chiwali's, Alala Plateau. Nov. 15, 1905.

Bill, brownish-horn-colour, paler at the base of the lower mandible; *iris*, brown; *feet*, dark greyish.

515. ♀ ad. Road to Chiwali's, Alala Plateau. Nov. 17, 1905.

Bill, dusky greyish, the tip black; *iris*, brown; *feet*, dusky.

Perhaps on migration: not observed elsewhere.

154. Chlorophoneus chrysogaster.

Malaconotus chrysogaster, Swains., "B. West Africa," p. 244, pl. 25 (1837: Senegal).

Chlorophoneus sulphureipectus, Bocage, "Orn. Angola," p. 234.

Malaconotus sulphureipectus, Shelley, *Ibis*, 1898, p. 554 (Mtondwe).

Laniarius sulphureipectus (part), Gadow, "Cat. B. Brit. Mus.," vol. 8, p. 159 (Zambesi); W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 40.

Chlorophoneus sulphureipectus chrysogaster, Reichen., "Vög. Afrikas," vol. 2, p. 562.

214. ♀ ad. E. bank of Loangwa. June 6, 1905.

255. ♂ juv. E. bank of Loangwa. June 20, 1905.

317. ♂ ad. E. bank of Loangwa. July 10, 1905.

320. ♀ ad. E. bank of Loangwa. July 11, 1905.

352. — Mterize River. July 25, 1905.

Common in the Loangwa Valley, especially in the more dense bush.

155. Dryoscopus hamatus.

Dryoscopus hamatus, Hartl., *P.Z.S.*, 1863, p. 106 (Unyamuezi); Gadow, "Cat. B. Brit. Mus.," vol. 8, p. 142.

Dryoscopus cubla hamatus, Reichen., "Vög. Afrikas," vol. 2, p. 594.

79. ♂ ad. Mololo's, near Petauke. Feb. 6, 1905.

Bill, blackish above, grey below; *iris*, reddish-brown; *feet*, grey.

107. ♂ ? Petauke. March 15, 1905.

156. ♂ ad. Petauke. April 21, 1905.

239. ♀ ad. Ulungu Mountain, West Loangwa. June 14, 1905.

Bill, black; *iris*, red; *feet*, dark grey.

260. ♀ ad. E. bank of Loangwa. June 22, 1905.

Bill, blackish above, grey below; *iris*, red-brown; *feet*, grey.

286. ♂ ad. E. bank of Loangwa. June 29, 1905.
Iris, orange-red.

318. ♂ ad. E. bank of Loangwa. July 10, 1905.
Bill, black.

328. ♀ ad. Mterize River. July 17, 1905.

446. ♂ ad. Kafulafuta River, N.W. Rhodesia. Oct. 16, 1905.

556. ♂ ad. Petauke. Dec. 29, 1905.
Bill, black; *iris*, red; *feet*, leaden.

Native name, "Chitule." Common everywhere.

156. **Dryoscopus mossambicus.**

Dryoscopus major mossambicus, Fischer and Reichen., *Journ. f. Ornith.*, 1880, p. 141 (Mossambique).

Dryoscopus mossambicus, W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 29.

Laniarius maior (part), Reichen., "Vög. Afrikas," vol. 2, p. 580.

224. ♂ ad. E. bank of Loangwa. June 7, 1905.
Bill, black; *iris*, reddish-brown; *feet*, dark grey.

285. ♂ ad. E. bank of Loangwa. June 29, 1905.
Iris, brown; *feet*, slate-colour.

311. ♀ ad. E. bank of Loangwa. July 8, 1905.
Bill, black, greyish at base; *iris*, dull red; *feet*, dark grey.

321. ♀ ad. E. bank of Loangwa. July 11, 1905.
Bill, black; *iris*, dull red; *feet*, grey.

330 ♂ ad. Mterize River. July 19, 1905.

437. ♂ ad. Ndola, N.W. Rhodesia. Oct. 12, 1905.
Bill, black; *iris*, brown; *feet*, dusky grey.

Native name, "Chuonti." Common in the dense bush near the banks of streams, in which it is very clever at concealing itself.

157. Pomatorhynchus senegalus.

Lanius senegalus, Linn., "Syst. Nat.," vol. 1, p. 137 (1766: Senegal).

Telephonus senegalus, Gadow, "Cat. B. Brit. Mus.," vol. 8, p. 124; Shelley, *Ibis*, 1898, p. 554 (Mwanza and Karonga); W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 19.

Pomatorhynchus senegalus, Reichen., "Vög. Afrikas," vol. 2, p. 547.

18. ♂ ad. Mseizi River, Feira district. July 18, 1904.

Bill, black and grey; *iris*, violet; *feet*, grey.

271. ♀ ad. E. bank of Loangwa. June 25, 1905.

Bill, black, whitish at base of lower mandible; *iris*, brown?; *feet*, grey.

400. ♀ ad. Road to Ndola. Sept. 18, 1905.

Bill, black; *iris*, purplish-blue; *feet*, greenish-grey.

"Mwanga" of the Asenga.

158. Pomatorhynchus australis.

Malaconotus australis, Smith, "Rep. Expl. Exped.," p. 44 (1836: South Africa, Northward and Eastward of Kurrichane, between 24° and 25° S. Lat.).

Telephonus australis, W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 22.

Pomatorhynchus australis, Reichen., "Vög. Afrikas," vol. 2, p. 544.

Telephonus trivirgatus, Smith; Bocage, "Orn. Angola," p. 224.

256. ♂ ad. E. bank of Loangwa. June 21, 1905.

Bill, horn, paler below; *iris*, brown; *feet*, pale grey.

336. ♀ ad. Mterize River. July 22, 1905.

Bill, greyish-horn-colour, paler below; *iris*, purple, with a narrow whitish inner margin; *feet*, grey.

Native name, "Mwanga." Generally inhabits somewhat dense bush, and occurs in pairs. Rather common.

Recorded here for the first time north of the Zambesi.

159. **Nilaus nigritemporalis.**

Nilaus nigritemporalis, Reichen., *Journ. f. Ornith.*, 1892, p. 218 (East Africa); Shelley, *Ibis*, 1898, p. 379 (Zomba Plains); W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 17; Reichen., "Vög. Afrikas," vol. 2, p. 541.

377. ♀ ad. Molilo's, near Petauke Aug. 19, 1905.

Bill, blackish, base of lower mandible bluish-grey; *iris*, red-brown; *feet*, lead-colour.

I only met with this one specimen.

Family PARIDÆ.

160. **Parus niger.**

Parus niger, Vieill., "N. Dict. d'Hist.," vol. 20, p. 325 (1820); *Id.*, "Enc. Meth.," vol. 2, p. 508 (1823: Cape of Good Hope); Bocage, "Orn. Angola," p. 285; Gadow, "Cat. B. Brit. Mus.," vol. 8, p. 7; W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 307; Reichen., "Vög. Afrikas," vol. 3, pp. 511, 841.

136. ♀ ad. Lichunio, near Petauke. April 7, 1905.

Bill, black; *iris*, reddish-brown; *feet*, black.

197. ♀ ad. Niamadzi River. May 31, 1905.

Bill, black; *iris*, brown; *feet*, grey.

Native name, "Tyentye." By no means uncommon.

161. **Parus masukuensis.**

Parus masukuensis, Shelley, "B. Africa," vol. 2, p. 238 (1900: Nyika Plateau and Masuku Range).

Parus rufiventris masukuensis, Reichen., "Vög. Afrikas," vol. 3, p. 515.

232. ♀ ad. Ulungu Mountain, West Loangwa district. June 12, 1905.

Bill, black; *iris*, pale yellow, shading to brown; *feet*, grey.

The only specimen met with.

162. **Parus parvirostris.**

Parus afer parvirostris, Shelley, "B. Africa," vol. 2, p. 241 (1900: Salisbury, Mashonaland).

Parus afer (part), Reichen., "Vög. Afrikas," vol. 3, p. 516.

402. ♀ ad. Road to Ndola, N.W. Rhodesia. Sept. 20, 1905.

434. ♂ ad. Ndola, N.W. Rhodesia. Oct. 11, 1905.

Bill, black; *iris*, brown; *feet*, lead colour.

Habits similar to those of *P. niger*.

Family ZOSTEROPIDÆ.

163. **Zosterops anderssoni.**

Zosterops anderssoni, Shelley, *Bull. Brit. Orn. Club*, vol. 1, p. 5 (1892: Damara Land); *Id.*, *Ibis*, 1898, p. 379 (Zomba); *Id.*, "B. Africa," vol. 2, p. 177, pl. 7, fig. 1; W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 300; Reichen., "Vög. Afrikas," vol. 3, p. 428.

Zosterops senegalensis, Bocage (*nec* Bonap.), "Orn. Angola," p. 288.

64. ♀ ad. Petauke. December 31, 1904.

Bill, black, whitish below; *iris*, brown; *feet*, grey.

365. ♂ ad. E. bank of Loangwa. Aug. 10, 1905.

Bill, blackish, paler at base of lower mandible; *iris*, light brown; *feet*, grey.

Generally in flocks, and is often in company with Sunbirds.

Family NECTARINIIDÆ.

164. **Cinnyris cupreus.**

Certhia cuprea, Shaw, "Gen. Zool.," vol. 8, p. 201 (1811: Malimba and other parts of Africa).

Nectarinia cuprea, Bocage, "Orn. Angola," p. 173.

Cinnyris cupreus, Shelley, "B. Africa," vol. 2, p. 36; Reichen., "Vög. Afrikas," vol. 3, p. 475.

84. ♂ ad. Petauke. Feb. 9, 1905.

102. ♂ ad. Petauke. March 6, 1905, with nest.

Bill, black; *iris*, dark brown; *feet*, black.

169. ♀ ad. Matambadzi River, Mbala Country. May 4, 1905.

Bill, black, yellow at gape; *iris*, brown; *feet*, black.

493. ♀ ad. Near the Lusenfwa River, Alala Plateau. Nov. 10, 1905.

503. ♂ juv. Road to Chiwali's, Alala Plateau. Nov. 13, 1905.

Bill, black; *iris*, brown; *feet*, black.

552. ♂ ad. Petauke. Dec. 29, 1905.

Bill, black; *iris*, dark brown; *feet*, black.

"Niasongwe" (generic name for *all* Sun-birds) among the Asenga.

"Kadiaulua" (generic name for *all* Sun-birds) among the Manganja and Lake tribes.

I found the nest of this species in March, and the male bird (No. 102) was snared on it.

This bird has not been found so near the Zambesi before, and does not appear to cross that river.

165. Cinnyris microrhynchus.

Cinnyris microrhynchus, Shelley, "Monogr. Nect.," p. 219, pl. 67 (1876: Zanzibar district); *Id.*, "B. Africa," vol. 2, p. 55.

Cinnyris mariquensis microrhynchus, Reichen., "Vög. Afrikas," vol. 3, p. 481.

445. ♂ ad. Road to Kapopo, N.W. Rhodesia. Oct. 15, 1905.

Bill, black; *iris*, dark brown; *feet*, black.

166. Cinnyris leucogaster.

Cinnyris leucogaster, Vieill., "N. Dict. d'Hist. Nat.," vol. 31, p. 515 (1819: Timor); Shelley, "B. Africa," vol. 2, p. 58; W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 281: Reichen., "Vög. Afrikas," vol. 3, p. 471.

Nectarinia talatala, Smith; Bocage, "Orn. Angola," p. 172.

263. ♂ ad. E. bank of Loangwa. June 23, 1905.

294. ♂ ad. E. bank of Loangwa. July 3, 1905.

340. ♀ ad. Mterize River. July 23, 1905.

369. ♂ ad. Bank of Loangwa, near Petauke. August 14, 1905.

Bill, black; *iris*, dark brown; *feet*, black. Not uncommon in the Loangwa Valley.

167. Cinnyris falkensteini.

Cinnyris falkensteini, Fischer and Reichen., *Journ. f. Ornith.*, 1884, p. 56 (Lake Naiwascha); Shelley, "B. Africa," vol. 2, p. 66, pl. 3, fig. 1.

Cinnyris venustus falkensteini, Reichen., "Vög. Afrikas," vol. 3, p. 474.

456. ♂ ad. Bank of Kafue, N.W. Rhodesia. Oct. 20, 1905.

Bill, pale red, yellow at gape; *iris*, brown; *feet*, greyish-brown.

This specimen seems to be quite identical with the series of *C. falkensteini* in the British Museum, and does not belong to *C. niassae* of Reichenow. (*t. c.*, p. 474)

168. Chalcomitra gutturalis.

Certhia gutturalis, Linn., "Syst. Nat.," vol. 1, p. 186 (1766: *nec* locality).

Nectarinia gutturalis, Bocage, "Orn. Angola," p. 164.

Chalcomitra gutturalis, Shelley, *Ibis*, 1898, p. 553 (Fort Hill); *Id.*, "B. Africa," vol. 2, p. 93; Reichen., "Vög. Afrikas," vol. 3, p. 464.

Cinnyris gutturalis, W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 286.

67. ♂ ad. Petauke. Feb. 2, 1905.

131. ♂ juv. Petauke. April 1, 1905.

132. ? ♂ juv. Petauke. April 1, 1905.

133. ? ♀ juv. Petauke. April 1, 1905.

Bill, black ; *iris*, dark brown ; *feet*, black.

These young individuals were remarkable for a patch of red brick-like dust at the base of the mandible, coming off when touched.

208. ♂ ad. E. bank of Loangwa. June 5, 1905.

234. ♂ ad. Ulungu Mountain, West Loangwa. June 13, 1905.

362. ♂ juv. Between Mterize River and Petauke. July 27, 1905.

Bill, black ; *iris*, dark brown ; *feet*, black.

The commonest species of Sun-bird in the country.

169. Chalcomitra deminuta.

Chalcomitra deminuta, Cab., *Orn. Centralbl.*, 1880, p. 143 (Angola) ; Shelley, "B. Africa," vol. 2, p. 105 ; Reichen., "Vög. Afrikas," vol. 3, p. 459.

Nectarinia amethystina, Bocage (*nec* Shaw), "Orn Angola," p. 163.

88. ♂ ad Petauke. Feb. 11, 1905.

89. ♂ ad. Petauke. Feb. 14, 1905.

95. ♂ ad. Petauke. Feb. 23, 1905.

456*a*. ♂ ad. Bank of Kafue, N.W. Rhodesia. Oct. 20, 1905.

Bill, black ; *iris*, dark brown ; *feet*, black.

170. Chalcomitra obscura.

Nectarinia obscura, Jard., "Nat. Hist., Nectar.," p. 353 (1843).

Nectarinia fraseri, Bocage (*nec* Jard.), "Orn. Angola," p. 544.

Cyanomitra obscura, Shelley, "B. Africa," vol. 2, p. 125.
Chalcomitra obscura, Reichen., "Vög. Afrikas," vol. 3, p. 450.

447. ♀ Kafulafuta River, N.W. Rhodesia. Oct. 17, 1905.

Bill, dark brown; *iris*, dark brown; *feet*, black.

The nest and eggs accompany this specimen. The range of this bird is given by Stark as extending from Eastern Cape Colony and Zululand to Portuguese East Africa. The occurrence and nesting of this species in the district of the Upper Kafue is therefore highly interesting.

171. Anthothreptes longuemarei.

Cinnyris longuemarei, Less., *Bull. Sci. Nat*, vol. 25, p. 242 (1831: Senegambia).
Anthreptes longmari, Bocage, "Orn. Angola," p. 545.
Anthothreptes longuemarei, Shelley, *Ibis*, 1898, p. 379 (Zomba), p. 553, (Mtondwe); *Id.*, "B. Africa," vol. 2, p. 144; Reichen., "Vög. Afrikas," vol. 3, p. 446.

404. ♀ ad. Road to Ndola. Sept. 20, 1905.

Bill, dark brownish; *feet*, blackish.

N.B.—Colours of soft parts of this specimen are not reliable. It was not picked up until the day after it had been shot.

172. Anthothreptes hypodila.

Nectarinia hypodila, Jard., "Contr. Orn.," 1851, p. 153 (Fernando Po).
Anthothreptes hypodila, Shelley, "B. Africa," vol. 2, p. 151.
Anthreptes collaris hypodilus, Reichen., "Vög. Afrikas," vol. 3, p. 443.

108. ♂ ad. Petauke. March 16, 1905.
124. ♂ ad. Petauke. March 27, 1905.
195. ♂ ad. Niamadzi River. May 29, 1905.

322. ♀ ad. Bank of Loangwa. July 12, 1905.
439. ♂ ad. Ndola, N.W. Rhodesia. Oct. 12, 1905.
553. ♂ ad. Petauke. Dec. 29, 1905.

A common species in wooded districts; always in small parties.

Family MOTACILLIDÆ.

173. Motacilla vidua.

Motacilla vidua, Sundev., *Oefv. k. Vetensk.-Akad. Förh. Stockholm*, 1850, p. 128 (Caffraria); Bocage, "Orn. Angola," p. 291; Sharpe, "Cat. B. Brit. Mus.," vol. 10, p. 488; W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 255; Reichen., "Vög. Afrikas," vol. 2, p. 296.

226. ♀ ad. E. bank of Loangwa. June 8, 1905.
Bill, black; *iris*, red brown; *feet*, black.
267. ♂ ad. E. bank of Loangwa. June 24, 1905.
383. ♂ ad. E. bank of Loangwa. Aug. 24, 1905.
Bill, black; *iris*, brown; *feet*, black.

Not particularly common, except near the bigger rivers. Nos. 226, 267 were shot on sand-banks.

Native names "Niatyetye" and "Niamdira."

174. Motacilla campestris.

Motacilla campestris, Pall., "Reis. Russ. Reichs," vol. 3, Anhang, p. 697 (1776); Sharpe, "Cat. B. Brit. Mus.," vol. 10, p. 510, pl. 6, figs. 1, 2; Shelley, *Ibis*, 1898, p. 379 (Mount Mlosa and Mount Zomba); W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 260.

Budytes campestris, Reichen., "Vög. Afrikas," vol. 3, p. 306.

564. Fort Jameson. Feb. 2, 1906.
Bill, brownish-horn-colour; *iris*, brown; *feet*, pinkish.

Not uncommon in the township and on the Angoni Plateau. Not seen in the Loangwa Valley.

175. Anthus nicholsoni.

Anthus nicholsoni, Sharpe, ed. Layard, "B. S. Africa," p. 536 (1884: Eland's Post, Vaal River, Kingwilliamstown, near Cape Town); *Id.*, "Cat. B. Brit. Mus.," vol. 10, p. 553; W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 249; Reichen., "Vög. Afrikas," vol. 3, p. 316.

Anthus campestris, Bocage (*nec* Vieill.), "Orn. Angola," p. 292.

418. ♀ ad. Ndola, N.W. Rhodesia. Oct. 2, 1905.

Bill, upper mandible blackish, lower mandible yellowish-horn-colour, with a black tip; *iris*, brown; *feet*, pinkish-horn-colour.

Snared on its nest, which contained two eggs slightly incubated. The nest was of dry shredded coarse grass and placed on the ground.

483. ♂ ad. Msofu River, Alala Plateau. Nov. 5, 1905.

Bill, brownish, lower mandible yellow; *iris*, brown; *feet*, yellowish-horn-colour.

176. Anthus leucophrys.

Anthus leucophrys, Vieill., "N. Dict. d'Hist. Nat.," vol. 26, p. 502 (1818: Cape of Good Hope); Reichen., "Vög. Afrikas," vol. 3, p. 316.

Anthus pyrrhonotus (*nec* Vieill.), Sharpe, "Cat. B. Brit. Mus.," vol. 20, p. 555; Shelley, *Ibis*, 1899, p. 367 (Tanganyika Plateau); W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 250

Anthus erythronotus, Bocage, "Orn. Angola," p. 295.

407. ♂ ad. Road to Ndola. Sept. 24, 1905.

412. ♂ ad. Road to Ndola. Sept. 27, 1905.

Bill, upper mandible blackish, lower mandible yellow with a black tip; *iris*, brown; *feet*, pale brownish.

"Mchocha" of the Alala.

177. **Macronyx croceus.**

Alauda crocea, Vieill., "N. Dict. d'Hist. Nat.," vol. 1, p. 365 (1816: Java).

Macronyx croceus, Bocage, "Orn. Angola," p. 297; Sharpe, "Cat. B. Brit. Mus.," vol. 10, p. 626; Shelley, *Ibis*, 1898, p. 379 (Zomba Plains), p. 553 (Mtondwe and Kasungu); W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 239; Reichen., "Vög. Afrikas," vol. 3, p. 321.

514. ♂ ad. Near Chiwali's, Alala Plateau. Nov. 17, 1905.

Bill, upper mandible black, lower mandible bluish-horn-colour, tipped dusky; *iris*, brown; *feet*, yellowish-brown.

In pairs on the Alala Plateau near Chiwali's.

Family ALAUDIDÆ.

178. **Mirafra nigricans.**

Alauda nigricans, Sundev., *Oefv. k. Vetensk.-Akad. Förh. Stockholm*, 1850, p. 99 (Limpopo, Upper Caffraria).

Mirafra nigricans, Bocage, "Orn. Angola," p. 376, pl. 8, fig. 1; Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 619; W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 207.

Pinarocorys nigricans, Reichen., "Vög. Afrikas," vol. 3, p. 348.

530. ♂ ad. E. bank of Loangwa. Dec. 16, 1905.

Native name, "Kalabompwe" (Chisenga).

The first locality for this species recorded north of the Zambesi.

Family FRINGILLIDÆ.

179. **Petronia petronella.**

Petronia petronella, Licht., "Nomencl. Av. Mus. Berol.," p. 47 (1854: Kafferland); Sharpe, "Cat. B. Brit. Mus.," vol. 12, p. 297: W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 157.

Xanthodira flavigula, Bocage, "Orn. Angola," p. 365.
Petronia flavigula, Shelley, *Ibis*, 1898, p. 379 (Zomba Plateau).
Petronia superciliaris (Blyth): Reichen., "Vög. Afrikas," vol. 3, p. 244.

196. ♀ ad. Niamadzi River, Loangwa Valley. May 29, 1905.

200. ♂ ad. Niamadzi River, Loangwa Valley. May 31, 1905.

240. ♂ ad. Ulungu Mountain, West Loangwa. June 14, 1905.

487. ♀ juv. Msofu River. Nov. 7, 1905.

Maxilla, brownish or blackish; *mandible*, pinkish-brown; *iris*, brown; *feet*, grey.

Native name "Kalinde." Fairly common but local; occurs chiefly in hilly districts.

180. **Serinus icterus**.

Fringilla ictera, Vieill., "Dict. d'Hist. Nat.," vol. 12, p. 170 (1817: l'Ile de France).
Serinus icterus, Sharpe, "Cat. B. Brit. Mus.," vol. 12, p. 356: Shelley, *Ibis*, 1898, p. 379 (Mount Mlosa): W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 173; Reichen., "Vög. Afrikas," vol. 3, p. 269.
Crithagra chrysopyga, Swains.; Bocage, "Orn. Angola," p. 368.

86. ♀ ad. Petauke. Feb. 9 1905.

92. ♂ ad. Petauke. Feb. 21, 1905.

193, 194. ♀ ♂ ad. Mterize River. May 24, 1905.

326. ♂ ad. E. bank of Loangwa. July 15, 1905.

333. ♂ ad. E. bank of Loangwa. July 19, 1905.

554, 555. ♀ ♂ ad. Petauke. Dec. 29, 1905.

Bill, brownish-horn-colour, the mandible paler; *iris*, brown; *feet*, brownish.

Native name "Niamkulasiye." A common species with a sweet twittering note.

181. Poliospiza melanochroa.

Serinus melanochrous, Reichen., *Orn. Monatsb.*, 1900, p. 122 (Ukinga).

Poliospiza melanochroa, Reichen., "Vög. Afrikas," vol. 3, p. 258.

385. ♀ ad. At the foot of the Niamgoza Mountains. Sept. 2, 1905.

401. ♂ ad. Road to Chiwalla's. Sept. 19, 1905.

Bill, dusky horn-colour; *iris*, dark brown; *feet*, dusky brown.

"Tondoni" of the Alala.

Hitherto only known from Ukinga *cf.* Reichen., *l.c.*

182. Emberiza flaviventris.

Passerina flaviventris, Vieill, "Enc. Méth.," vol. 3, p. 929 (1823).

Fringillaria flaviventris, Bocage, "Orn. Angola," p. 370.

Emberiza flaviventris, Sharpe, "Cat. B. Brit. Mus.," vol. 12, p. 499; Shelley, *Ibis*, 1898, p. 379 (Zomba); W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 184; Reichen., "Vög. Afrikas," vol. 3, p. 284.

35, 36. ♀ ♂ ad. Loangwa Valley, Portuguese East Africa. Sept. 7, 1904.

36*a*. ♂ ad. Loangwa Valley, Portuguese East Africa. Sept. 8, 1904.

38. ♂ ad. Loangwa Valley, Portuguese East Africa. Sept. 11, 1904.

40, 41. ♂ ♀ ad. Loangwa Valley, Portuguese East Africa. Sept. 13, 1904.

199. ♂ ad. Niamadzi River, Loangwa Valley. May 31, 1905.

382. ♀ ad. Petauke. Aug. 24, 1905.

Bill, brown or pinkish-brown; *iris*, brown or reddish-brown; *feet*, pinkish-brown.

Not uncommon, but rather local. Several specimens obtained by native snares at water holes.

Family PLOCEIDÆ.

183. Vidua serena.

Emberiza serena, Linn., "Syst. Nat.," vol. 1, p. 312 (1766).

Vidua serina, Reichen., "Vög. Afrikas," vol. 3, p. 217.

Vidua principalis (Linn.), Bocage, "Orn. Angola," p. 345; Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 203; W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p 145.

90. ♀ ad. Petauke. Feb. 14, 1905.

247, 248. ♀ ♂ ad. E. bank of Loangwa. June 19, 1905.

249, 250, 251. ♀ ♂ ♂ ad. E. bank of Loangwa. June 19, 1905.

In large flocks.

184. Steganura paradisea.

Emberiza paradisea, Linn., "Syst. Nat.," vol. 1, p. 312 (1766: Angola).

Vidua paradisea, Bocage, "Orn. Angola," p. 346: Shelley, *Ibis*, 1898, p. 554 (Lake Namaramba, Mtondwe and Chiradzula); W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 149.

Steganura paradisea, Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 211; Reichen., "Vög. Afrikas," vol. 3, p. 223.

73. ♂ ad. (Summer). Molilo's, near Petauke. Feb. 3, 1905.

85. ♂ ad. (Summer). Petauke. Feb. 9, 1905.

Bill, black; *iris*, dark brown; *feet*, dark brown.

471. ? ♀ ad. (Winter). Near Kapopo. Oct. 27, 1905.

Bill, pinkish-horn, paler below; *iris*, brown; *feet*, brownish colour.

Native name for male in summer plumage, "Niantindirifundwa."

185. Penthetria ardens.

Fringilla ardens, Bodd., "Tabl. Pl. Enl.," p. 39 (1783).

Penthetria ardens, Bocage, "Orn. Angola," p. 559; Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 215.

Coliipasser ardens, Shelley, *Ibis*, 1898, p. 379 (Mount Mlosa).
Coliopasser ardens, W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 142.
Coliuspasser ardens, Reichen., "Vög. Afrikas," vol. 3, p. 135.

130. ♂ ad. (Summer). Petauke. March 31, 1905.

Bill, black; *iris*, nearly black; *feet*, black.

329. ♂ juv. (Winter). Mterize River. July 19, 1905.

Bill, pinkish-brown, paler below; *iris*, dark brown; *feet*, pale pinkish-brown.

Distinctly scarce in this country. The male shot was one of only two seen.

Native name, "Niamdera."

186. Penthetria hartlaubi.

Penthetria hartlaubi, Bocage, *Jorn. Acad. Lisb.*, vol. 6, p. 259 (1878: Caconda); *Id.*, "Orn. Angola," p. 341; Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 219.
Coliuspasser hartlaubi, Reichen., "Vög. Afrikas," vol. 3, p. 142.

512. ♂ ad. Near Chiwali's, Alala Plateau. Nov. 16, 1905.

Bill, black above, bluish-white below; *iris*, brown; *feet*, black.

Not uncommon in long grass on banks of streams, etc., on High Plateau country: not met with East of Mchinga Range.

The most eastern record of this somewhat rare species.

187. Pyromelana flammiceps.

Euplectes flammiceps, Swains., "B. West Africa," vol. 1, p. 186, pl. 13 (1837: Senegal); Bocage, "Orn. Angola," p. 335.
Pyromelana flammiceps, Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 228; Shelley, *Ibis*, 1898, p. 379 (Zomba Plains), p. 554 (Mtondwe).

77. ♂ ad. Molilo's, near Petauke. Feb. 4, 1905.

Bill, black; *iris*, very dark brown; *feet*, dark grey.

Common in reed beds. "Chisosi" of the Asenga.

188. **Pyromelana nigrifrons.**

Pyromelana nigrifrons, Böhm, *Journ. f. Ornith.*, 1884, p. 177 (Karema, Lake Tanganyika); Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 233; Reichen., "Vög. Afrikas," vol. 3, p. 122.

47. ♀ ad. Mezi River, Portuguese East Africa. Oct. 3, 1904.

Bill, pink; *iris*, dark brown; *feet*, brownish-pink.

82. ♂ ad. (Summer). Molilo's, near Petauke. Feb. 7, 1905.

Bill, black; *iris*, dark brown; *feet*, pale brown.

543. ♀? Molilo's, near Petauke. Dec. 25, 1905.

Bill, brownish-horn-colour, paler below; *iris*, brown; *feet*, brownish-pink.

"Chisosi" of the Asenga.

189. **Pyromelana xanthomelæna.**

Euplectes xanthomelas, Rüpp., "Neue Wirb., Vög.," p. 94 (1835-40: Temben et Simen); Reichen., "Vög. Afrikas," vol. 3, p. 128.

Pyromelana xanthomelæna, Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 239; Shelley, *Ibis*, 1898, p. 379 (Zomba).

Pyromelana capensis xanthomelæna, W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 133.

33. ♂ ? juv. Loangwa Valley, Portuguese East Africa. Sept. 7, 1904.

55. ♂ ad. (Summer). Petauke. Dec. 16, 1904.

71. ♂ ad. (Summer). Molilo's, near Petauke. Feb. 3, 1905.

337. ♀ ad. (Winter). Mterize River. July 22, 1905.

341, 342, 343. ♂ ad. (Winter). Mterize River. July 24, 1905.

354. ♂ juv. Mterize River. July 25, 1905.

356. ♂ ad. (Winter). Mterize River. July 25, 1905.

531. ♂ ad. (Summer). E. bank of Loangwa. Dec. 17, 1905.

Bill (Summer ♂ ♂), black above, white below; (Winter ♂ ♂ and ♀ ♀), pinkish-brown, paler below; *iris*, dark brown; *feet* (Summer), dark brown; (Winter), pale pinkish-brown.

All known as "Mpeta" to the natives when in their winter dress.

190. **Ploceipasser pectoralis.**

Philagrus pectoralis, Peters, *Journ. f. Ornith.*, 1868, p. 133 (Inhambane).

Ploceipasser pectoralis, Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 247; W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 85; Reichen., "Vög. Afrikas," vol. 3, p. 13.

140. ♀ ad. Lichunio, near Petauke. April 11, 1905.

149. ♀ ad. Lichunio, near Petauke. April 13, 1905.

319. ♂ ad. E. bank of Loangwa. July 10, 1905.

375. ♂ ad. Lichunio, near Petauke. Aug. 18, 1905.

386, 387. ♂ ♀ ad. Lukashashi River. Sept. 3, 1905.

Bill, black; *iris*, reddish-brown; *feet*, brownish-grey.

A very noisy bird. Entirely confined to "Mopani" flats, where it occurs in flocks. It is a very inquisitive bird and not at all wary.

"Mwanchilo" of the Asenga.

191. **Quelea lathami.**

Loxia lathami, Smith, "Rep. S. Afr. Expl. Exped.," 1836, p. 51.

Quelea quelea, Sharpe (*nec* Linn.), "Cat. B. Brit. Mus.," vol. 13, p. 257, pl. 10, fig. 3; Shelley, *Ibis.*, 1898, p. 379 (Mount Mlosa); W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 122.

Ploceus sanguinirostris (Linn.), Bocage, "Orn. Angola," p. 320.

Quelia sanguinirostris lathami, Smith ; Reichen., "Vög. Afrikas," vol. 3, p. 110.

92. ♀ ad. Petauke. Feb. 17, 1905.

Bill, yellow ; *iris*, dark brown ; *feet*, pinkish-brown.

544. ♀ ad. Molilo's, near Petauke. Dec. 25, 1905.

Bill, orange ; *iris*, brown ; *orbit*, reddish-brown ; *feet*, orange-brown.

545. ♂ ad. Molilo's, near Petauke. Dec. 25, 1905.

Bill, crimson ; *iris*, brown ; *orbit*, reddish-brown ; *feet*, orange-brown.

192. Quelea cardinalis.

Hyphantica cardinalis, Hartl., *Journ. f. Ornith.*, 1880, p. 325, pl. 1, figs. 1 and 2 (Lado).

Quelea cardinalis, Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 256, pl. 10, fig. 2 ; Reichen., "Vög. Afrikas," vol. 3, p. 112.

83. ♂ ad. Molilo's, near Petauke. Feb. 7, 1905.

Bill, blackish-horn-colour ; *iris*, dark brown ; *feet*, pale brown.

Native name, "Mpeta."

This is a much more southern locality for this species than has hitherto been recorded.

193. Spermestes scutatus.

Spermestes scutatus, Heugl., *Journ. f. Ornith.*, 1863, p. 18 (Dembea and West Abyssinia) ; Shelley, *Ibis*, 1898, p. 399 (Mount Mlosa) ; W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 112.

Spermestes scutata, Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 265 ; Reichen., "Vög. Afrikas," vol. 3, p. 150.

Spermestes cucullata, Bocage (*nec* Swains.), "Orn. Angola," p. 350.

393. ♀ ad. Alala Plateau. Sept. 12, 1905.

475. ♀ ad. Near Kapopo, N.W. Rhodesia. Oct. 27, 1905.

Bill, black above, whitish below; *iris*, brown; *feet*, black.

Known to Angoni natives as "Lichirichiti." I did not meet with it in the Loangwa Valley.

194. Amauresthes fringilloides.

Ploceus fringilloides, Lafr., *Mag. de Zool.*, 1835, pl. 48.

Amauresthes fringilloides, Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 267; Reichen., "Vög. Afrikas," vol. 3, p. 155.

Spermestes fringilloides, W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 111.

109, 110. ♂ ♀ ad. Petauke. March 17, 1905.

205. ♀ juv. Niamadzi River, Loangwa Valley. June 2, 1905.

547. ♂ ad. Petauke. Dec. 27, 1905.

Bill, black, blue-grey below; *iris*, brown; *feet*, black.

195. Lagonosticta niveiguttata.

Spermophaga niveiguttata, Peters, *Journ. f. Ornith.*, 1868, p. 133 (Inhambane).

Lagonosticta niveiguttata, Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 274.

Hypargus niveiguttatus, Shelley, *Ibis*, 1898, p. 379 (Mount Mlosa).

Lagonosticta niveoguttata, W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 95.

Hypargos niveoguttata, Reichen., "Vög. Afrikas," vol. 3, p 157.

323. ♀ ad. Mterize River. July 13, 1905.

Bill, bluish, with blackish tip; *iris*, very dark brown; *feet*, grey.

346. ♂ ad. Mterize River. July 24, 1905.

466. ♂ ad. Shores of Lake near Kapopo. Oct. 25, 1905.

Maxilla, dusky-bluish ; *mandible*, blue, with a black tip ; *orbit*, bright blue ; *iris*, dark brown ; *feet*, dusky grey.

Native name, "Kakatimbwa." Rather a shy little bird. Hides persistently in long grass and the thick bush on the banks of streams.

196. **Lagonosticta brunneiceps.**

Lagonosticta brunneiceps, Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 277 ; W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 94 ; Reichen., "Vög. Afrikas," vol. 3, p. 196.

252. ♂ ad. E. bank of Loangwa. June 19, 1905.

Bill, dull red, marked black ; *iris*, red? ; *feet*, pale horn-colour.

378. ♀ ad, Molilo's, near Petauke. Aug. 19, 1905.

Bill, blackish above, pink below ; *iris*, brick-red ; *feet*, brownish.

379. ♂ juv. Molilo's, near Petauke. Aug. 19, 1905.

Bill, etc., as 378.

All the small Wax-bills are known to the natives as "Yongwe."

197. **Lagonosticta rhodoparia.**

Lagonosticta rhodopareia, Heugl., *Journ. f. Ornith.*, 1868, p. 16 (Keren District, Bogos Land) ; Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 282 (Dar-es-Salaam) ; Shelley, *Ibis*, 1898, p. 379 (Mount Mlosa) ; Reichen., "Vög. Afrikas," vol. 3, p. 200.

187. ♀ ad. Mbala Country. May 18, 1905.

325. ♂ ad. Mterize River. July 15, 1905.

327. ♂ ad. Mterize River. July 16, 1905.

513. ♀ ad. Near Chiwali's, Alala Plateau. Nov. 16, 1905.

Bill, bluish-black ; *iris*, brown ; *feet*, dark grey.

"Niasisi" of the Asenga. Commonly seen in flocks, usually in company with *Estrilda angolensis.*

198. **Hypochaera codringtoni**, sp. n.

Similis *H. chalybeatae*, sed major, et nitore viridiscentiore, subalaribus totis pure albis distinguenda.

This species is distinguished from *H. amauropteryx* by its white bill and bottle-green secondaries, which are like the back.

I have much pleasure in dedicating this species to my friend, Mr. Robert Codrington, Administrator of N.E. Rhodesia.

74. ♂ ad. (Type). Molilo's, near Petauke. Feb. 3, 1905.

97. ♂ ad. Petauke. Feb. 24, 1905.

Bill, whitish ; *iris*, brown ; *feet*, salmon orange.

199. **Sporaeginthus subflavus.**

Fringilla subflava, Vieill., "N. Dict. d'Hist. Nat.," vol. 30, p. 575 (1819 : Sénégal).

Estrilda subflava, Bocage, "Orn. Angola," p. 360 ; Shelley, *Ibis*, 1898, p. 379 (Mount Mlosa) ; W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 105 ; Reichen., "Vög. Afrikas," vol. 3, p. 186.

Sporaeginthus subflavus, Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 324.

167. ♀ ? Matambadzi River, Mbala Country. May 4, 1905.

Bill, coral-red, both mandibles black in the middle line ; *iris*, brick-red ; *feet*, pinkish-brown.

200. **Estrilda astrilda.**

Loxia astrild, Linn., "Syst. Nat.," vol. 1, p. 303 (1766).

Estrilda astrild, Bocage, "Orn. Angola," p. 358.

Estrilda astrilda, Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 391; Reichen., "Vög. Afrikas," vol. 3, p. 178; W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 98.

165, 166. ♂ ♀ ad. Matambadzi River. May 4, 1905.

Bill, coral-red; *iris*, brown; *feet*, black.

420. ♂ ad. Near Ndola, N.W. Rhodesia. Oct. 3, 1905.

Bill, scarlet; *iris*, brown; *feet*, black.

Most of the Wax-bills are known to the natives as "Yongwe."

201. Estrilda angolensis.

Fringilla angolensis, Linn., "Syst. Nat.," vol. 1, p. 323 (1766: Angola).

Uræginthus phœnicotis, Bocage (*nec* Linn.), "Orn. Angola," p. 354.

Granatina angolensis, Shelley, *Ibis*, 1898, p. 379 (Mount Mlosa and Zomba Plains), p. 554 (Lake Shirwa).

Estrilda angolensis, Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 402; W. L. Sclater, "Fauna S. Africa, Birds," vol. 5, p. 102.

Uræginthus bengalus angolensis, Reichen., "Vög. Afrikas," vol. 3, p. 209.

99. ♀ ad. Petauke. March 2, 1905. With nest and eggs.

101. ♀ ad. Petauke. March 2, 1905.

308. ♂ ad. E. bank of Loangwa. July 7, 1905.

335. ♀ ad. Mterize River. July 20, 1905.

Bill, violet, tip dusky; *iris*, red; *feet*, pink.

A common species. Native name "Niasisi."

The nest of this bird was composed entirely of fine grass, and was of a great depth. It contained one white egg. In common with the nests of many birds in the country, more especially the smaller Weavers, the nest was placed close to those of a species of Hymenoptera of

the genus *Polistes*, called "Mesasangu" by the natives. These insects sting abominably if any one approaches their nest or disturbs them in any way.

202. Anaplectes rubriceps.

Ploceus rubriceps, Sundev., *Oefv. k. Vetensk.-Akad. Förh. Stockholm*, 1850, p. 97 (Caffraria).

Anaplectes rubriceps, Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 411; W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 74; Reichen., "Vög. Afrikas," vol. 3, p. 25.

31. ♂ juv. Near Pakolwe Mountain, Portuguese East Africa. Aug. 24, 1904.

61, 62. ♀ ad. Petauke. Dec. 29, 1904.

116. ♀ juv. Petauke. March 23, 1905.

380. ♂ ad. Petauke. Aug. 23, 1905.

526. ♂ ad. Petauke. Dec. 8, 1905.

Bill, orange; *iris*, reddish-brown; *feet*, pinkish-brown.

Nos. 61, 62 are remarkable for having red heads like adult males.

Native name, "Lusizi."

203. Sitagra crocata.

Hyphantornis crocata, Hartl., *Abh. Naturwiss. Ver. Bremen*, vol. 7, p. 100 (1881 : Magungo).

Sitagra ocularia, Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 427.

Hyphanturgus ocularius, Shelley, *Ibis*, 1898, p. 379 (Mount Mlosa.)

Ploceus ocularius crocatus, Reichen., "Vög. Afrikas," vol. 3, p. 46.

500. ♂ ad. On the road to Chiwali's, Alala Plateau. Nov. 13, 1905.

Bill, black; *iris*, olive-grey; *feet*, grey.

523. ♀ ad. Petauke. Dec. 6, 1905.

Bill, black; *iris*, light yellow; *feet*, grey.

204. Hyphantornis galbula.

Ploceus galbula, Rüpp., "Neue Wirb., Vög.," p. 92, pl. 32, fig. 2 (1835-40: Abyssinian Coast); Reichen., "Vög. Afrikas," vol. 3, p. 95.

Hyphantornis galbula, Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 442.

198. ♀ ad. Niamadzi River. May 31, 1905.

216. ♂ ad. E. bank of Loangwa. June 6, 1905.

246. ♀ ad. E. bank of Loangwa. June 18, 1905.

Bill, brownish-horn-colour, paler below; *iris*, orange, (198) brown: *feet*, pinkish-brown.

361 ♀ ad. Mterize River. July 27, 1905.

Bill, brownish-horn-colour, paler below; *iris*, yellow-brown; *feet*, pale brownish.

364. ♂ ad. Msanzara River. Aug. 5, 1905.

Bill, pale horn-colour; *iris*, dark brown; *feet*, pinkish-grey.

This identification is only put forward tentatively, as the collection contains no male in breeding plumage.

205. Hyphantornis xanthops.

Hyphantornis xanthops, Hartl., *Ibis*, 1862, pp. 335, 342 (Angola); Bocage, "Orn. Angola," p. 327; Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 447.

Xanthophilus xanthops, Shelley, *Ibis*, 1898, p. 379 (Zomba).

Ploceus xanthops, Reichen., "Vög. Afrikas," vol. 3, p. 88.

65. ♂ ad. Petauke. Jan. 16, 1905.

Bill, black; *iris*, yellow; *feet*, pinkish-brown.

128. ♀ juv. Petauke. March 30, 1905.

129. ♂ juv. Petauke. March 31, 1905.

Bill, black; *iris*, orange; *feet*, pink.

338. ♀ ad. Mterize River. July 23, 1905.

Bill, black; *iris*, sulphur-yellow; *feet*, pinkish-brown.

344, 348. ♀. Mterize River. July 24, 1905.

Bill, horn-colour, paler below; (344), *iris*, light ochre, (348) greyish-yellow; *feet*, light brownish.

This is rather a solitary and shy bird for a weaver.

All Weavers called "Shonko" by the natives. I generally found the crop of this bird to contain grain from native gardens.

206. **Hyphantornis nigriceps.**

Hyphantornis nigriceps, Layard, "B. South Africa," p. 180 (1867: Kuruman); Bocage, "Orn. Angola," p. 324; Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 456; Shelley, *Ibis*, 1898, p. 379 (Zomba); W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 561.

Ploceus nigriceps, Reichen., "Vög. Afrikas," vol. 3, p. 62.

42, ♀ ad. E. bank of Loangwa, Portuguese East Africa. Sept. 14, 1904.

221. ♀ ? E. bank of Loangwa. June 7, 1905.

334. ♀. Mterize River. July 20, 1905.

Bill, brownish-horn-colour, paler below; *iris*, brown or reddish-brown; *feet*, brownish.

394. ♂ ad. On the Plateau East of Mkushi. Sept. 12, 1905.

397. ♂ ad. Road to Ndola, N.W. Rhodesia. Sept. 16, 1905.

Bill, black; *iris*, orange-red; *feet*, pinkish-brown.

207. **Hyphantornis shelleyi.**

Hyphantornis shelleyi, Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 464 (1890); W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 62.

Ploceus auricapillus, Swains.; Reichen., "Vög. Afrikas," vol. 3, p. 79.

72. ♀ ad. (nesting). Molilo's, near Petauke. Feb. 3, 1905.

Bill, pinkish ; *iris*, brown ; *feet*, pink.

75. ♂ ad. (nesting). Molilo's, near Petauke. Feb. 3, 1905.

Bill, black ; *iris*, orange ; *feet*, pinkish-brown.

546. ♀ ad. Molilo's, near Petauke. Dec. 26, 1905.

Bill, brownish-horn-colour, paler below ; *iris*, brown ; *feet*, pinkish-brown.

Family ORIOLIDÆ.

208. **Oriolus notatus**.

Oriolus notatus, Peters, *Journ. f. Ornith.*, 1868, p. 132 (Tete, Zambesi) ; Sharpe, "Cat. B. Brit. Mus.," vol. 3, p. 196 ; Bocage, "Orn. Angola," p. 196 ; Shelley, *Ibis*, 1898, p. 554 (Mwanza, Lake Shirwa and Tanganyika Plateau) ; W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 50 ; Reichen., "Vög. Afrikas," vol. 2, p. 656.

57. ♂ ad. Petauke. Dec. 22, 1904.
66. ♂ ad. Petauke. Jan. 21, 1905.
105. ♂ ad. Petauke. March 13, 1905.
112. ♀ ad. Petauke. March 18, 1905.
117. ♂ juv. Petauke. March 24, 1905.

Bill, ♂ ♂ pinkish-brown ; *iris*, red ; *feet*, grey or greyish-black.

Bill, ♀ and ♂ juv. black ; *iris*, brown ; *feet*, grey.

Common everywhere. Both species of Oriole known to the natives as "Mwidio."

209. **Oriolus larvatus**.

Oriolus larvatus, Licht., "Verz. Doubl.," p. 20 (1823 : Caffraria) ; Sharpe, "Cat. B. Brit. Mus.," vol. 3, p. 217 ; Shelley, *Ibis*, 1898, p. 379 (Zomba), p. 554 (Lake Shirwa and Mwanza) ; W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 51 ; Reichen., "Vög. Afrikas," vol. 2, p. 658.

15. ♂ ad. Mseizi River, Feira District. July 15, 1904.

189 ♂ ad. Mbala Country. May 19, 1905.

381. ♀ ad. Petauke. Aug. 23, 1905.

485. ♂ ad. Msofu River, Alala Plateau. Nov. 5, 1905.

Bill, pink; *iris*, blood-red; *feet*, black or dusky.

Not quite so common as and more wary than *O. notatus*.

Family DICRURIDÆ.

210. Dicrurus ludwigii.

Dicrurus ludwigii, Smith, "Illustr. Zool. S. Afr.," pl. 34 (1839: Forests adjoining Port Natal); Sharpe, "Cat. B. Brit. Mus.," vol. 3, p. 233; W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 267; Reichen., "Vög. Afrikas," vol. 2, p. 652.

473. ♂ ad. Near Kapopo, N.W. Rhodesia. Oct. 27, 1905.

Bill, black; *iris*, orange-red; *feet*, black.

211. Dicrurus afer.

Corvus afer, Licht., "Cat. Rer. Nat. Hamb.," p. 10 (1793).

Dicrurus afer, Shelley, *Ibis*, 1898, p. 554 (Kasungu); W. L. Sclater, "Fauna S. Africa, Birds," vol. 2, p. 265; Reichen., "Vög. Afrikas," vol. 2, p. 646.

Buchanga assimilis (Bechst.); Sharpe, "Cat. B. Brit. Mus.," vol. 3, p. 247.

Dicrurus divaricatus, (Licht.); Bocage, "Orn. Angola," p. 244.

76. ♂. Molilo's, near Petauke. Feb. 3, 1905.

96. ♀. Petauke. Feb. 24, 1905.

121. ♂. Petauke. March 25, 1905.

Bill, black; *iris*, red; *feet*, black.

"Mtiengo" of the Asenga. The Drongo is common everywhere, and comes in large numbers to grass fires.

Family EULABETIDÆ.

212. Cinnyricinclus verreauxi.

Pholidauges verreauxi, Bocage, *in* Finsch & Hartl., "Vög. Ostafr.," p. 867 (1870: Caconda, Benguella); *Id.*, "Orn. Angola," p. 314, pl. 5; Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 123; Shelley, *Ibis*, 1898, p. 379 (Zomba), p. 554 (Tanganyika Plateau: Songwe and Fort Hill).

Pholidauges leucogaster verreauxi, W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 44.

Cinnyricinclus verreauxi, Reichen., "Vög. Afrikas," vol. 2, p. 680.

68. ? ♀ juv. Petauke. Feb. 2, 1905.

178. ♀ ad. Mbala Country. May 11, 1905.

430, 431. ♂ ♀ ad. Ndola, N.W. Rhodesia. Oct. 10, 1905.

443. ♂ ad. Ndola, N.W. Rhodesia. Oct. 13, 1905.

527, 528. ♂ ♀ ad. Petauke. Dec. 8, 1905.

Bill, black; *iris* (♂) sulphur-yellow, (♀) brown; *feet*, (♂) black; (♀) dusky.

A common species in Summer; not nearly so plentiful in Winter.

"Kuzumwero" of Nyasa tribes.

213. Lamprotornis mevesi.

Juida mevesii, Wahlb., *Oefv. k. Vetensk.-Akad. Förh. Stockholm*, 1856, p. 174; *Id.*, *Journ. f. Ornith.*, 1857, p. 1 (Tonka).

Lamprotornis mevesi, Bocage, "Orn. Angola," p. 303; Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 157; Shelley, *Ibis*, 1898, p. 554 (Upper Shiré); W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 32; Reichen., "Vög. Afrikas," vol. 2, p. 711.

6. ♂ ad. Bank of Zambesi. June 18, 1904.

206. ♀ ad. E. bank of Loangwa. June 4, 1905.

264. ♀ ad. E. bank of Loangwa. June 24, 1905.

366. ♂ ad. E. bank of Loangwa. August 11, 1905.

Bill, black; *iris*, dark brown; *feet*, black.

Occurs in flocks in the Loangwa Valley. "Mzaze" of the Asenga.

"Nguzinguzi" of the Lake tribes.

214. **Lamprocolius glaucovirens.**

Lamprocolius glaucovirens, Elliot, *Ann. Mag. Nat. Hist.* (4), vol. 20, p. 169 (1877: Gaboon); Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 173, pl. 7, fig. 2.

Lamprocolius splendidus, Bocage (*nec* Vieill.), "Orn. Angola," p. 307.

Lamprocolius splendidus glaucovirens, Reichen., "Vög. Afrikas," vol. 2, p. 693.

426. ♂ ad. Ndola, N.W. Rhodesia. Oct. 9, 1905.

444. ♀ ad. Ndola, N.W. Rhodesia. Oct. 13, 1905.

470. ♀ ad. Near Kapopo, N.W. Rhodesia. Oct. 26, 1905.

Bill, black; *iris*, creamy-white; *feet*, black.

Not met with East of these localities. Has a remarkable variety of notes. Generally occurs in dense jungle. A fruit-eater.

"Mkusikusi" of the Alamba.

This is an entirely new locality for the species, and is extremely interesting as extending its range so far to the South and East.

215. **Lamprocolius sycobius.**

Lamprocolius sycobius, Hartl., *Journ. f. Ornith.*, 1859, p. 19 (Tete); Bocage, "Orn. Angola," p. 308; Sharpe, "Cat. B. Brit. Mus.," vol. 13, p. 178; Shelley, *Ibis*, 1898, p. 379 (Zomba Plains), p. 554 (Likwenu); W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 41.

Lamprocolius chalybæus sycobius, Reichen., "Vög. Afrikas," vol. 2, p. 688.

17. ♂ ad. Bank of Zambesi, Feira district. July 16, 1904.

203. ♂ ad. Niamadzi River, Loangwa Valley. June 2, 1905.

204. ? Niamadzi River, Loangwa Valley. June 2, 1905.

Bill, black; *iris*, orange; *feet*, black.

Native name, "Niapwriri." Common in the Loangwa Valley.

Family CORVIDÆ.

216. **Corvultur albicollis.**

Corvus albicollis, Lath., "Ind. Orn.," vol. 1, p. 151 (1790: Africa).

Corvultur albicollis, Sharpe, "Cat. B. Brit. Mus.," vol. 3, p. 24; W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 10; Reichen., "Vög. Afrikas," vol. 2, p. 640.

46. ♀ ad. Mezi River, Portuguese East Africa. Sept. 24, 1904.

Bill, black, tipped white; *iris*, dull red; *feet*, black.

Not uncommon in pairs in the more hilly parts of the country.

"Chikwalala" of the Asenga, "Kungulwe" of the Chikunda.

217. **Corvus scapulatus.**

Corvus scapulatus, Daud., "Traité d'Orn.," vol. 2, p. 232 (1800: Senegal, Cape of Good Hope, and Madagascar); Sharpe, "Cat. B. Brit. Mus.," vol. 3, p. 22; Bocage, "Orn. Angola," p. 300; W. L. Sclater, "Fauna S. Africa, Birds," vol. 1, p. 12; Reichen., "Vög. Afrikas," vol. 2, p. 634.

392. ♂ ad. Edge of Mchinga Escarpment. Sept. 11, 1905.

Bill, black ; *iris*, brown ; *feet*, black.

This bird is common round the villages on the plateau, but was not observed in the Loangwa Valley. Its gizzard was full of millet.

"Chankoli" of the Alala.

CISTICOLA STOEHRI
HYPOCHÆRA CODRINGTONI

Manchester Memoirs, Vol. li. (1907), *No.* **11.**

XI. Further notes on the adventitious vegetation of the sandhills of St. Anne's-on-the-Sea, North Lancashire (vice-county 60).

By CHARLES BAILEY, M.Sc., F.L.S.

Received 8th April, and read 9th April, 1907.

Five years ago, in the Society's *Manchester Memoirs*, vol. 47, No. 2, 1902, the occurrence was reported of four somewhat conspicuous alien plants on the sandhills of St. Anne's. In the subsequent years many other non-aboriginal plants have been noticed in the same locality, and the object of the present communication is to put their names on record.

The source of this adventitious flora was puzzling, but there seems no reason to doubt that the sweepings of corn ships and of docks, and the siftings of grain imports, used as food for poultry, are the main source of the species about to be enumerated. The sandhills of the St. Anne's coast have long been utilised for housing poultry, and, with the rapid advance of the township in population, the building area has extended, and more and more of the sandhills has been absorbed, or removed, in the process. When the hen-pens are taken down, and the ground-surface is disturbed, plants spring up quite different from the herbage native to the neighbourhood. Few of these aliens reach maturity, as the passage of workmen and vehicles over them, in numerous cases, destroys large numbers, and the surprise is that so many species remain to reward the search of the botanist. A list of more than forty species is quite worthy of a large ballast-discharging port.

June 18th, 1907.

The various portions of the sandhills, although so much alike, are very unequal in their yield of alien species. Some of these areas have been systematically searched without disclosing a single stranger, or if there be an occasional unusual plant it is an escape from cultivation, like *Alyssum maritimum*, *Tamarix gallica*, *Anaphalis margaritacea*, *Calendula officinalis*, &c.

The ground which has proved the most fruitful in alien vegetation is that which is bounded by the streets now called Richmond Road, Park Road, St. Thomas's Road, and Orchard Road. This ground is bisected by All Saints' Road, which runs parallel to Park Road and Orchard Road. This area has supplied most of the species here enumerated; when they have been derived beyond it the particular locality is specified. It will be seen from the native countries to which the plants belong, how the probability is increased that they are largely due to the grain-siftings and sweepings of American, rather than continental, wheat and other crops. The pace at which the problem of the housing of the people is being faced at St. Anne's, prevents any hope of most of these plants attaining the status of colonists, as sufficient time has not been granted them for multiplying.

Rapistrum orientale, DC., is a Mediterranean species which has occurred in some plenty on one spot off All Saints' Road. It fruited abundantly last year, but the locality is now covered by the erection of new dwelling houses. Greece, southern Italy, Corsica, and Sardinia are its European headquarters.

Rapistrum rugosum, Berger, a closely allied species, was found growing with *R. orientale*, but in much less quantity. It was flowering at the time that *orientale* had

fruited. It has a much wider European distribution than that species.

Sisymbrium pannonicum, Jacq., = *S. altissimum*, Linn., a plant of central and eastern Europe and western Asia, is widely spread about St. Anne's, and grows in profusion. It is plentiful on both sides of the railway bridge in St. Thomas's Road, in various spots on the sandhills, and is quite naturalised on the coast from Fleetwood to Preston.

Diplotaxis muralis, DC., is a species fairly frequent at St. Anne's, but is rarely associated with most of the plants enumerated in this list. It has occurred on the sandhills opposite the North Promenade, at the links end of St. Andrew's Road South, and it is plentiful upon the cindered roads of St. George's Gardens. Only a small portion of the plants belongs to type *muralis;* by far the larger portion falls under Syme's var. *Babingtonii.* In 1903, upon the extension of Beach Road eastwards, it appeared in the greatest profusion, along with *Verbascum Thapsus*, Linn., *Hyoscyamus niger*, Linn., *Veronica agrestis*, Linn., *Veronica Tournefortii*, C. Gmel., *Œnothera Lamarkiana*, Ser. in DC.

Lepidium Draba, Linn., is known to me in only one small colony on the coast towards South Shore, near the Ormerod Children's Convalescent Home, upon what was once a waste heap, consisting for the most part of spent hops. It occurs over almost the whole of Europe, and it reached this country nearly a hundred years ago at Ramsgate, in the litter used by the fever-stricken soldiers who returned from the unfortunate Walcheren expedition.

Lepidium ruderale, Linn., though native to this country, must be considered an alien at St. Anne's, as it

is never found out of their company. It is an occasional plant on the sandy ground east and west of the railway line.

Silene sp. A dwarf catch-fly, about six inches in height, having the look of *S. noctiflora*, Linn., has occurred. By the courtesy of the Director of the Royal Gardens, Kew, I submitted this plant, and many others in this list, for naming or confirmation, but the authorities there were unable to identify this species.

Saponaria officinalis, Linn., is widely spread at St. Anne's, but from the circumstance that the flowers are generally double, it may be surmised to be of garden origin. It is the most plentiful on the north side of St. Anne's, especially about St. Leonard's Road and St. George's Gardens. I have never found fruiting examples.

Malva borealis, Wallm., = *M. pusilla*, Sm., was extremely abundant last year on a plot covered this year with houses. The Lancashire species, *M. rotundifolia*, Linn., was growing with it, both species fruiting freely.

Melilotus officinalis, Lam., = *M. arvensis*, Wallr., and *M. alba*, Desr., = *M. vulgaris*, Willd., are frequent plants, the last-named being the less frequent of the two.

Vicia villosa, Roth. The locality for this beautiful claret-coloured vetch, reported as occurring five years ago in the hollows of the sandhills on the north side of St. Thomas's Church, has been overwhelmed by a large sand-hill having drifted fifty yards to the eastward. I have sought in vain for another station for the plant.

Œnothera Lamarkiana, Seringe in DC., is the most conspicuous of the aliens of St. Anne's, and grows in profusion towards the north and the south, preferring the sunny slopes of the sandhills. Old residents inform me that they have known the plant for more than 20 years.

and this is confirmed by my gathering the same species on the other side of the estuary of the Ribble, from 1881 onwards, my earliest herbarium example bearing that date. The species is North American, and it is recorded as having occurred in Virginia, Carolina, and Georgia, but the exact localities are not known. Lamarck's original specimens in the museum at Paris, upon which Seringe founded the species in the "Prodromus," bear the date 1789. In my former paper, this plant was referred to as *Œ. biennis*, Linn., in the broad sense in which that species is accepted; many systematists include under it various species and subspecies, such as *cruciata*, Nutt.; *gauroides*, Hornem.; *grandiflora*, Soland.; *suaveolens*, Desf.; and others. Lancashire botanists have been accepting it as a large-flowered garden form of *biennis*; but it is not the same plant as that which I collected for *biennis* in Jersey and other parts of England; nor does it agree with Crosby specimens in my herbarium; while the American *biennis* of the neighbourhood of New York does not coincide with the *biennis* of the western hemisphere. The Crosby *Œnothera* has been established there, and on other parts of the Lancashire coast, for a hundred years. Two years ago, Dr. W. O. Focke, of Bremen, was inquiring about an *Œnothera* which was spreading on the sandy shores of west Germany (see *Journal of Botany*, 1905, p. 324), and thinking that the St. Anne's plant might be the same, I forwarded examples to that botanist of the root-leaves of the Crosby plant, and complete examples of the St Anne's plant, pointing out their differences. Dr. Focke identified the St. Anne's plant as *Œ. Lamarkiana*, Ser. in DC.—the species which Dr. Hugo de Vries has made so celebrated by his observations on its mutability, in his "Die Mutationstheorie," (Leipzig, 1901 and 1902) and his "Species and Varieties; their

origin by mutation" (London and Chicago 1905; 2nd ed., 1907). It is thoroughly established on both sides of the Ribble, and the accompanying plates (*Plates* I to VI) will give some idea of the luxuriance with which it grows at St. Anne's.

Œnothera humifusa, Nutt., is another American species which has certainly not reached St. Anne's by a garden route. It is a wavy-leaved, small-flowered, prostrate, short-fruited species, delighting in the drier portions of the sandhills. I thought it might prove to be *Œ. sinuata*, Linn., but it has been determined at Kew to be *humifusa*, Nutt. I saw it for the first time in September and October of last year, near St. Thomas's Church, and also at the southern end of All Saints' Road.

Anaphalis margaritacea, Benth. and Hook., is another plant of American origin. It has occurred on the sands of the North Promenade, in a situation in which the refuse of gardens is frequently tipped, and is not, therefore, likely to have reached St. Anne's with grain siftings.

Helianthus tuberosus, Linn., is generally distributed over several portions of the sandhills, especially about St. Andrew's Road North, Beach Road, and St. George's Gardens. Although this species is in cultivation, it occurs so often in association with the other aliens here enumerated, that it may be regarded as sharing in their common origin. When once established it remains persistent, by reason of its creeping rootstock, when the ground is not interfered with.

Helianthus petiolaris, Nutt. Another sunflower introduced in seed is the species thus named by the authorities at Kew. It is a dwarf species, and would doubtless occur more plentifully on the sandhills were it allowed to grow undisturbed; its conspicuous flowers, however, lead to its

early destruction. The Americans call it the prairie, or western, sunflower.

Cyclachæna xanthifolia, Fresen., = *Iva xanthifolia*, Nutt., occurred in a single example last season; but it was very diminutive, not being more than nine inches in height when in fruit. It has previously been reported from Par harbour, near St. Austell, in Cornwall. Like many American plants it is wealthy in its local names, viz.—false sunflower, giant ragweed, marsh elder, &c.

Ambrosia artemisifolia, Linn. St. Anne's is remarkable for the large number of species of *Ambrosia*, and its allies which occur there; there are, at least, four, all American or Canadian. Of these the only one which can be said to have become thoroughly established, is the species to which attention was drawn in the paper in the 47th volume of the Society's *Memoirs*, viz., *A. artemisifolia*, Linn. I have had this plant under observation during the last five years, and am quite satisfied that it has been a colonist on this part of the Lancashire coast for many years. An eighteen years' resident has told me recently that it was well established at St. Anne's when he first came to the district, but that he could never ascertain its name; he remembers it in profusion on the land which is covered by the houses and gardens of St. Andrew's Road South. Unlike most of the other aliens noted in this paper it monopolises the sandy surface wherever it occurs, the underground stolons figured on Plates I and II, which illustrated that paper, giving the plant great staying and spreading power. The American botanical publications almost uniformly describe the plant as an annual, although the persistent underground portions are well known for *A. psilostachya*, DC. (See figure in *Bulletin of the Experiment Station of the Kansas*

State Agricultural College, Manhattan, No. 76, February, 1898).

There are three principal stations for it on the sandhills, or the remains of the sandhills. One, where it was first detected, is on the sandy flat on the north side of St. Thomas's Church. In 1902 it was almost the prevailing plant, being surpassed only by *Convolvulus arvensis*, Linn., and *Sisymbrium pannonicum*, Jacq. In 1903 the season was favourable for its growth, and it flowered profusely, without producing fruit, though diligently sought for; some of the examples, especially those at the edge of St. Thomas's Road, were two feet in height. Unfortunately, in the spring of the following year, strong and long-continued sea winds led to the drifting of sand on an extensive scale from an intervening sandhill; the sand was impelled up the western slope, and drifted down the eastern slope, with the result that in that and succeeding years the base of the old sandhill has extended eastwards for nearly a hundred yards, completely burying the larger portion of the patch which existed in 1902. It is only a question of time how long it will remain free from further drifts; some houses built on the South Drive last year check the force of the sea wind, but such houses are the forerunners of others, which will ultimately destroy the plant in this station. As a reminiscence of the luxurious growth of this plant on this site, reference may be made to the accompanying plates, VII and VIII. The drifting sandhill referred to above lies to the right, but outside the limits of the plates.

The second locality is now enclosed by the fence which surrounds the ground upon which St. Thomas's Church is built. The patch runs half the length of the wall at the rear of the dwelling house in Victoria Road, which forms part of the eastern boundary of the church-

yard. At present a large sandhill lies on the north just beyond the *Ambrosia* patch, from which the wind is constantly moving the sand to the adjoining grounds. So long as this hill remains in the churchyard, the plant is liable to be overwhelmed by north winds.

A third large area crowded with the plant occurs near the iron church on the western edge of Orchard Road. In this station three of its sides are built upon, and, in consequence, it does not receive as much direct sunlight as in the other stations, with the result that the plants are more spindly, attaining a height of from two to three feet, and they do not flower as early as on the open sandhills. Here again, absorption of one half the total area has taken place last winter by the erection of three houses; judging by the rate at which building is progressing in this part of St. Anne's, the present year will probably see the remaining half built upon.

Ambrosia artemisifolia is becoming a persistent colonist in many parts of western Europe, coming in with lucerne, clover, and other seeds imported from Canada and the United States. An interesting paper by M. Edouard Heckel on the way it has become naturalised in France during the last thirty years will be found in the *Bulletin de la Société Botanique de France* for 1906, vol. 53, pp. 600--620; the reproduction of the photographs given in the *Bulletin* of the plant as it grows at Eaux de Challes, near Chambéry, in Savoy, may be compared with the plates representing the St. Anne's plants. This species is also spreading in England. I reported to the Watson Botanical Exchange Club its occurrence in 1903 in one of the botanical excursions of the British Association during the 1903 meeting at Southport—when it was found at Birkdale by Mr. Henry Ball; and Mr. Arthur A. Dallman, of Liverpool, has just

recorded its occurrence in Flintshire in the *Journal of Botany* for this month (vol. 45, p. 144).

I met with a solitary example of an *Ambrosia* in open ground much disturbed by lime-pits and building operations, which I thought might be referred to *A. psilostachya*, DC.; it had minute spines at the crown of the fruit—a character which it shares with *A. artemisifolia*. But at Kew it was determined to be *artemisifolia*. It is the only example which I have met with of that species reaching the fruiting stage, its reproduction at St. Anne's being evidently by the underground stolons.

Ambrosia trifida, Linn. This is another American species, known under the names of big ragweed, horse-weed, and wild hemp, which is frequently found growing in this country, but always in ground suggesting non-nativity. Mr. Jas. E. McDonald sent it to me from railway sidings at Heaton Mersey last year. It occurred at St. Anne's in great profusion, with fully-matured fruit, last October, on the western side of All Saints' Road—a site now covered by houses. At St. Anne's it reproduces itself from seeds very freely. The neighbourhood of the docks at Birkenhead thirty or more years ago used to furnish *A. elatior*, Linn., but this species has not, so far, been detected at St. Anne's.

Gaertneria (*Franseria*) *acanthicarpa*, (Hook.), Britton, = *Ambrosia acanthicarpa*, Hook., also occurred, but only as a solitary example.

Hemizonia pungens, Torr. and Gray, a Californian plant, and one of the American tarweeds, or spikeweeds, has occurred several times, but in no large numbers. It is a dwarf species belonging to the *Compositæ*, with small sessile heads of yellow flowers, and rather rigid subulate undivided stem-leaves. I was unable to identify it, and I

am indebted to Kew for the name. It has been met with in England previously. (See "Alien Flora of Britain," by S. T. Dunn, p. 116.)

Hieracium aurantiacum, Linn., a native of the Alps, grows upon a portion of the Lytham and St. Anne's golf links, situate to the east of the railway line. Its station is far away from any houses, but it is so frequently cultivated in gardens as to be likely to be an escape from cultivation. The links are private ground, and I am indebted to Miss Marian Wood, of the North Drive, for the discovery of the plant at this station.

Lactuca virosa, Linn., occurred in the sandhills off St. Thomas's Road, in 1903 ; but I have not noticed it in subsequent years. It is a south British species not native in Lancashire.

Anchusa officinalis, Linn., var. *vulgaris*, Rchb., although occasionally found established in this country, must be classed with the casuals here enumerated. There were a few strong plants of it, sadly dismembered and trodden under foot.

Lycopsis orientalis, Linn., occurred as a large straggling plant, owing its preservation to bushy *Chenopodiaceæ*.

Echium? sp. Several examples of a plant that had the look of an *Echium* appeared on the building ground. It had grown no further than producing large rosettes of root-leaves radiating from a stout rootstock; the individual leaves were numerous and measured from twelve to eighteen inches long, which gave the rosettes, lying flat on the ground, a striking appearance. I left all the rosettes growing in the hope of tracing its further growth this year, but they now all lie under houses.

Echinospermum Lappula, Lehm., was a fourth boraginaceous plant growing on the same ground and in a

somewhat starved state. I have collected this species, of course as a casual, on the opposite shore, as at Formby; it is often found on railway banks, sidings, and goods yards. It is a European plant, naturalised in the United States, and therefore likely to occur with other casuals from that country.

Solanum rostratum, Dunal. This yellow-flowered spiny-stemmed nightshade of the American prairies was not infrequent. It is a plant which Mr. J. A. Wheldon tells me has been found in several parts of South Lancashire. I named it from cultivated examples in my herbarium from Strasbourg. Buffalo-bur, bull-nettle, Texas thistle, buffalo thistle, Mexican thistle, Colorado-bur, spiny nightshade, are some of the cognomens applied to it in the United States.

Solanum triflorum, Nutt., is another sand-loving prairie nightshade, with small whitish straw-coloured flowers, which occurred with ripe fruit, but examples were not numerous.

Lycopersicum esculentum, Mill. = *Lycopersicon Lycopersicon* (Linn.), Karst., might be omitted from this list, as the tomato is so frequently found on waste heaps in this country; but it is also so fully naturalised in the United States that its association with the other casuals suggests its inclusion with them, as derived from the same over-sea source.

Leonurus Cardiaca, Linn., was collected in September, 1901, close to Ansdell, and in no way associated with the other plants here named. Nevertheless, it is naturalised in the United States, and may have been introduced with grain siftings of American origin.

Salvia? sp. A labiate plant having root leaves sug-

gesting a *Salvia*, did not mature sufficiently to determine its name, when frost cut off its further growth.

Sideritis montana, Linn. This widely-distributed continental plant was represented last year by an example or two.

Chenopodium opulifolium, Schrad., a widely spread European species was, last autumn, the most prominent plant on the sandy land now covered with houses; the density of its growth prevented it from being trampled upon, and, with the following members of the same genus, served as a shelter for the more lowly-growing casuals.

Chenopodium ficifolium, Sm., which Mr. Wheldon has found pretty frequent in South Lancashire, was represented at St. Anne's by three or four bushes. It only flowered in the middle of October last year. Neither of these two species is American, as are the two following species.

Chenopodium leptophyllum (Moq.), Nutt., is somewhat variable. I had named only one of three sheets sent to Kew as this species, but the two unnamed sheets were returned under the same name. It was nearly as plentiful as *opulifolium*. The plant is frequently met with on the shores of the inland lakes and sandy coasts of the States.

Chenopodium anthelminticum, Linn., the wormseed of the Americans, was represented also, but sparsely; being a low-growing plant, much of the traffic over the area may have destroyed it. The leaves of the St. Anne's plants were very narrow and pinched. It is a European species naturalised in the United States.

Polygonum sp. A small-leaved knotweed belonging to the *aviculare* group was noticed in the autumn, with the flowers large in proportion to the slenderness of the branches, and appearing throughout their entire length. I have not been able to ascertain its name.

Asphodelus fistulosus, Linn., a small rush-like plant of the Greek islands, the Adriatic coasts, and the Mediterranean generally, was frequent both in the flowering and fruiting stages. The grasses were few :—

Setaria viridis, Beauv., and *S. glauca*, Beauv.—the green and yellow foxtail grasses of the Americans, were not uncommon ; they are of wide distribution in Europe.

Bromus maximus, Desf., was found 24th October, 1903, by Mr. J. Cosmo Melvill and myself with *Vicia villosa*, Roth, in the land on the north side of St. Thomas's Church. I have not detected it since.

EXPLANATIONS OF PLATES I TO VIII.

PLATE I.—*Œnothera Lamarkiana*, Ser. in DC. In a tennis ground within St. George's Gardens, St. Anne's-on-the-Sea, 17th September, 1906. This ground is kept mown during the summer; after the last mowing the plants are left undisturbed for the autumn, winter and spring, with the result that fresh shoots are put forth which both flower and fruit. The plants represented in the plate were two to three feet in height, and bore large flowers three inches in diameter. In May, 1907, to prepare the ground for the summer, the gardeners had uprooted all the evening primroses which were visible, amounting to several barrow-loads.

PLATE II.—*Œnothera Lamarkiana*, Ser. in DC. View looking across the sandhills westward from the eastern end of Beach Road, St. Anne's-on-the-Sea. The large grass in the foreground is *Elymus arenarius*, Linn., a frequent sandhills plant of St. Anne's. Photographed August, 1906.

PLATE III.—*Œnothera Lamarkiana*, Ser. in DC. View taken from the same standpoint as in *Plate* II, but looking south-west. The house on the horizon is on the North Drive, at the corner of Beach Road. Photographed August, 1906.

PLATE IV.—*Œnothera Lamarkiana*, Ser. in DC. View just within the fence of St. George's Gardens, St. Anne's-on-the-Sea, at the corner of Beach Road, August, 1906. *Plates* I to IV were photographed between six and seven o'clock, a.m.; by noon most of the flowers have either closed or fallen.

PLATE V.—Fruiting example of *Œnothera Lamarkiana*, Ser. in DC., growing on the south side of Atherstone House, North Drive, St. Anne's-on-the-Sea, looking eastward, and within the building yard of Messrs. Porritt and Son. Photographed October, 1906.

PLATE VI.—Mature fruiting examples of *Œnothera Lamarkiana*, Ser. in DC., taken from the same site as in *Plate* V. The plants in both plates were four feet in height.

PLATE VII.—View showing the dense growth of *Ambrosia artemisifolia*, Linn., on the sandhills on the north side of St. Thomas's Road, St. Anne's-on-the-Sea, 9th October, 1906. The houses on the left are in St. Andrew's Road South, and the dark masonry between the two notice-boards, and immediately over the two small uncovered spots near the centre of the plate, is the bridge in St. Thomas's Road over the railway line. Near this bridge, on either side of the railway, *Sisymbrium pannonicum*, Jacq., is plentiful. The strong westerly gales of the end of April and beginning of May, 1907, had overwhelmed a good portion of the foreground, nor had the progress of the drifting sand ceased at that date.

PLATE VIII.—A nearer view of *Ambrosia artemisifolia*, Linn., with the flower spikes somewhat better defined than in *Plate* VII, and from the same site. The plant with the oblong-sagittate leaves is *Convolvulus arvensis*, Linn.; and the undergrowth is *Salix repens*, Linn., *Viola Curtisii*, Forster, &c.

These eight illustrations are reproductions of photographs taken by Mr. Fred Heyworth, of St. Andrew's Road South, St. Anne's-on-the-Sea. The first six are from my paper on "De Lamarck's Evening Primrose (*Œnothera Lamarkiana*) on the sandhills of St. Anne's-on-the-Sea," read at the annual meeting of the Manchester Field Club, 29th January, 1907.

C. B.

Œnothera Lamarkiana, at St. Anne's on the Sea.

Oscillatoria Lamarckiana at St. Anne's on the Sea

Œnothera Lamarkiana, at St. Anne's on the Sea

See page 11

Mau

Ophrys Lutea at St. Annes-on-the-Sea

Œnothera Lamarkiana, at St. Anne's on the-Sea.

(See page 9)

Ambrosia artemisifolia, at St. Anne's-on-the-Sea.

Ambrosia artemisifolia, at St. Anne's-on-the-Sea.

[See page 16.]

Mau

Manchester Memoirs, Vol. li. (1907), *No.* **12.**

XII. On a Collection of Fishes, Batrachians, and Reptiles, made by Mr. S. A. Neave in Rhodesia, North of the Zambesi, with Field Notes by the Collector.

By G. A. BOULENGER, F.R.S.

(Communicated by Dr. W. E. Hoyle, F.R.S.E.)

Received and read March 26th, 1907.

All localities are *North Eastern Rhodesia* unless specially recorded otherwise. All fishes are from waters within the *Zambesi* watershed.

Feira at the junction of the Zambesi and Loangwa rivers.

Mezi River, a tributary of the left bank of the Loangwa, in Portuguese territory.

Mterize River, a tributary of the left bank of the Loangwa, in British territory.

The *Lukashashi River*, a big tributary of the R. bank of the Lusenfwa, which itself is a tributary of the Loangwa.

The *Msofu River*, a tributary of the Lusenfwa, on the Alala Plateau.

The *Kafulafuta River* is a tributary of the Kafue River.

The *Mbala Country* is some high open country to the S.E. of Petauke.

Petauke is the Government Station in the E. Loangwa district.

PISCES.

MORMYRIDÆ.

1. **Mormyrus longirostris**, Peters.

1071. Lukashashi River. September 9, 1905.
"Native name 'Mikupe.'"

June 12th, 1907.

The parichnos communicates with the surface before reaching the leaf scar by the two lateral scars.

There are two shallow depressions, on the lower surface of the cushion, which pass in laterally until they are underneath the parichnos strands.

The parichnos broadens out to reach these pits, and this broadening is of rather finer parenchyma than the normal parichnos, and also seems to have fewer air spaces. (*Fig.* 5, *Plate II.*)

The normal structure of the parichnos is that it is a strand of parenchyma, the cells of which are rather small, iso-diametric, and more or less spherical, so as to leave considerable intercellular spaces.

This description applies to the majority of the sections, but in the series in the Williamson collection, No. 380 B—L, in several places this pit is seen to be filled up with a typically aërenchymatous tissue. (See *Fig.* 11, *Plate III.*) This tissue is composed of star-shaped cells which leave very marked air spaces, and agree exactly with those described by Professor Weiss (:07) in some isolated sections of *Lepidodendron.*

In this last case, however, the pit is empty, and the aërenchymatous tissue opens into it, being separated from its cavity by an epidermis.

This difference suggests that the lateral scars seen in impressions are really of two types, one in which they represent actual pits, during the life of the plants, and the other in which there are really no pits but a patch of spongy and easily decaying tissue.

The pit in *L. vasculare*, described by Hovelacque ('92), seems to differ from those in Professor Weiss's sections, in that it has no obvious connection with the parichnos, which is separated from it by many apparently rather thick-walled cells.

A slight amount of periderm formation seems to have taken place under the epidermis in some sections of leaf cushions of *L. Hickii.*

A definite absiccession layer does not seem to have been formed at the base of the leaves.

One fact in connection with the leaf bases is interesting, and at first rather confusing to anyone working out their anatomy, which is that deep cracks developed, separating the leaf cushions from one another, and thereby giving an exaggerated idea of their projection. All references to the level at which the leaf bases separate refer to the real original level of separation, and not to the bottom of this crack.

Branching of L. Hickii.

Two types of branching are represented in *L. Hickii*, normal equal dichotomy, and an unequal dichotomy, called by Williamson "Halonial Branching."

The actual bifurcation in a case of equal dichotomy has only been seen in a block, but it was no doubt quite normal.

An interesting point is that in one case the dichotomous branch is "Halonial," the "Halonial" branching being in a plane at right angles to that of the main branch.

The "Halonial" branches are arranged in two vertical rows, any two branches on the same side being separated by a considerable vertical interval, sometimes about 50 mm.

The branches of opposite sides are often nearly opposite one another.

Branching of stele.

The branching of the stele is quite of the usual Halonial type (Williamson, '72, '81, '83, '93), (Weiss, :02),

SILURIDÆ.

11. **Schilbe mystus,** L.

01. Loangwa River. August, 1904.

12. **Amphilius platychir,** Gthr.

Petauke. December 27, 1905.

"In the Petauke stream amongst the mountains."

CICHLIDÆ.

13. **Tilapia natalensis,** M. Web.

06. Loangwa River. August, 1904.

BATRACHIA.

BUFONIDÆ.

1. **Bufo regularis,** Reuss.

1072. Lukashashi River, N.E. Rhodesia. September 9, 1905.

1043. Petauke. February 21, 1905.

1050. Petauke. March 19, 1905.

1042. Petauke. February 20, 1905.

1045. Petauke. February 22, 1905.

1022. Mterize River, East Loangwa District. November 1, 1904.

1067. Mterize River, East Loangwa District. July 27, 1905.

1018. Mterize River, East Loangwa District. October 28, 1904.

2. **Bufo carens,** A. Smith.

1039. Petauke, East Loangwa District, N.E. Rhodesia. January 26, 1905.

ENGYSTOMATIDÆ.

3. **Phrynomantis bifasciata,** A Smith.

1083. Lukashashi River. November 22, 1905.

"Native name, 'Kambwali.'"

4. **Breviceps mossambicus,** Peters.

1019. Mterize River. October 30, 1904.

1084. Lukashashi River, N.E. Rhodesia. November 23, 1905.

RANIDÆ.

5. **Rana angolensis,** Bocage.

1091. Petauke. December 27, 1905.

1097. Petauke. January 2, 1906.

6. **Rana adspersa,** Bibr.

1007. Loangwa River. August 4, 1904.

1085. Lukashashi River. November 23, 1905.

"This large species seldom seen, owing to its burrowing habits. Chiefly confined to the large river valleys. Native name 'Chisi.' Eaten and considered a delicacy by some natives."

7. **Rappia cinctiventris,** Cope.

1066. Mterize River. July 23, 1905.

"Native name, 'Kalamatira.' Apparently rather a scarce species in the country.

"The general name for all frogs and toads amongst the natives is 'Chuli.' They are much afraid of them."

REPTILIA.

CHELONIA.

TESTUDINIDÆ.

1. **Testudo pardalis,** Bell.

1012. Loangwa River. August 12, 1904.
1040. Petauke, N.E. Rhodesia. February 1, 1905.

2. **Cinixys belliana,** Gray.

1089. Petauke. December 8, 1905

PELOMEDUSIDÆ.

3. **Sternothærus sinuatus,** A. Smith.

1088. Petauke, N.E. Rhodesia. December 7, 1905.

4. **Sternothærus nigricans,** Donnd.

1078. Msofu River. November 6, 1905.
1081. Near Chiwali's, Alala Plateau, N.W. Rhodesia. November 18, 1905.

The latter specimen may be referred to the typical form, the former to the *var. castanea*, Schw., as defined by Siebenrock (in Voeltzkow, "Reis. Ostafr." vol. 2, p. 34, 1906).

a. (1081) Length of shell, 90 millim.; width, 74; depth, 39. "Tympano-frontal" suture very short; suture between the humeral shields shorter than the intergular.

b. (1078) Length of shell, 100 millim.; width, 70; depth, 42. "Tympano-frontal" suture longer; suture between the humeral shields as long as the intergular.

According to Siebenrock, the true *S. nigricans* would be confined to the East Coast of Madagascar.

"Tortoises of various species are common in the country, especially during the rains. Native name, 'Furo.' Judging by the number of skeletons seen, large numbers must be eaten by the ground Hornbill (*Bucorvus caffer*)."

LACERTILIA.

GECKONIDÆ.

5. **Lygodactylus capensis.** A. Smith.

G. Petauke. December, 1904—January, 1905.

6. **Pachydactylus bibronii,** A. Smith.

F. Petauke, East Loangwa District, N.E. Rhodesia. December, 1904—January, 1905.

1051. Petauke, East Loangwa District, N.E. Rhodesia. March 28, 1905.

AGAMIDÆ.

7. **Agama aculeata,** L.

1014. Mezi River, Portuguese East Africa. September 24, 1904.

8. **Agama mossambica,** Peters.

1017. Mterize River. October 26, 1904.
1027. Petauke. November 16, 1904.
1038. Petauke. January 20, 1905.
1070. Petauke. August 26, 1905.

9. **Agama atricollis,** A. Smith.

1028. Petauke. November 17, 1904.

VARANIDÆ.

10. **Varanus albigularis,** Donnd.

1087. Bank of Loangwa. November 27, 1905.
"Native name, 'Mfumba.'"

11. **Varanus niloticus,** L.

1035. Petauke. December 22, 1904.
1058. Bank of Loangwa. June 8, 1905.
"Native name, 'Mbulu.'"
"The flesh of the *Varanus* is considered a great delicacy by the natives. Many small species of lizards are called 'Mtololiko' by the natives."

LACERTIDÆ.

12. **Ichnotropis squamulosa,** Peters.

C. Petauke. February and March, 1905.
1057. Bank of Loangwa. June 6, 1905.

GERRHOSAURIDÆ.

13. **Gerrhosaurus major,** A. Dum.

1003. Near the Zambesi, Feira District. July 12, 1904.

14. **Gerrhosaurus nigrolineatus,** Hallow.

1032. Petauke. December 9, 1904.
1060. ? June 11, 1905.
1061. Ulungu Mountain. June 15, 1905.

15. **Gerrhosaurus flavigularis,** Wiegm.

1064. Bank of Loangwa. July 11, 1905.

SCINCIDÆ.

16. **Mabuia quinquetæniata,** L.

1090. Petauke. December 27, 1905.
A. Loangwa Valley. May and June, 1905.

17. **Mabuia varia,** Peters.

D. Petauke. 1905.

D_1. Petauke. December, 1904—January, 1905.

18. **Mabuia striata,** Peters.

1095. Petauke. December 29, 1905.

E. Feira District. June—August, 1904.

19. **Ablepharus wahlbergii,** A. Smith.

B., B.i., B.ii. Loangwa Valley. May and June, 1905.

B.iii. Petauke. 1905.

RHIPTOGLOSSA.

CHAMÆLEONTIDÆ.

20. **Chamæleon dilepis,** Leach.

1006. Zambesi River, near Feira. July 23, 1904.

1025. Petauke. November 11, 1904.

OPHIDIA.

TYPHLOPIDÆ.

21. **Typhlops mucruso,** Peters.

H., H.i. Mezi River, Portuguese East Africa. Sept., 1904.

1030. Petauke. November 30, 1904.

"Native name 'Chulisi.'"

GLAUCONIIDÆ.

22. **Glauconia longicauda,** Peters.

J. Ulungu Mountain. June 15, 1905.

"Native generic name for snakes 'Njoka.'"

23. **Glauconia nigricans,** Schleg.

I. (5 individuals). Petauke. December, 1904—January, 1905.

I.i. Loangwa Valley. May 8—June 7, 1905.

BOIDÆ.

24. **Python sebæ**, Gm.

1082. Lukashashi River. November 21, 1905.

1068. Petauke. August 7, 1905.

"Common in many places, though large individuals scarce. No. 1082 bought from a native, and said to have been killed by a leopard. Native name 'Nsarto.' Eaten by many natives."

COLUBRIDÆ.

25. **Tropidonotus olivaceus**, Peters

1049. Petauke. March 16, 1905.

26. **Helicops bicolor**, Gthr.

1080. Alala Plateau, N.W. Rhodesia. November 16, 1905.

This snake was known from Angola only.

27. **Lycophidium capense**, A. Smith.

1011. Loangwa Valley. Portuguese East Africa. August 22, 1904.

1079. Alala Plateau, N.W. Rhodesia. November 15, 1905.

28. **Chlorophis neglectus**, Peters.

1063. Bank of Loangwa. July 3, 1905.

1021. Mterize River. October 31, 1904.

1016. Mterize River. October 26, 1904.

1065. Mterize River. July 21, 1905.

"No. 1063 was dug out of a termites' nest in the height of the dry season, the ground being so hard that it could hardly have entered except during the previous rains."

29. **Philothamnus semivariegatus**, A. Smith.

1031. Petauke. December 7, 1904.

1041. Petauke. February 3, 1905.

30. **Coronella semiornata,** Peters.

1015. Bank of Loangwa, Feira District. October 14, 1904.

31. **Prosymna ambigua,** Bocage.

1054. Mbala Country, East Loangwa District. May 6, 1905.

32. **Dasypeltis scabra,** L.

1023. Mterize River. November 4, 1904.

33. **Tarbophis semiannulatus,** A. Smith.

1033. Petauke. December 10, 1904.

1036. Petauke. December 22, 1904.

34. **Leptodira hotamboeia,** Laur.

1020. Mterize River. October 30, 1904.

1024. Mterize River. November 4, 1904.

1008. Bank of Loangwa, Feira District. August 8, 1904.

35. **Rhamphiophis oxyrhynchus,** Reinh.

1037. Petauke. January 15, 1905.

36. **Psammophis sibilans,** L.

1004. Near the Zambesi, Feira District. July 13, 1904.

1010. Loangwa Valley, Portuguese East Africa. August 22, 1904.

37. **Thelotornis kirtlandii,** Hallow.

1009. Loangwa Valley, Portuguese East Africa. August 20, 1904.

1005. Near the Zambesi, Feira District. July 15, 1904.

1069. Petauke. August 26, 1905.

"A very common species. Native name 'Kalakukwiti.'"

38. **Dispholidus typus**, A. Smith.

1047. Petauke. March 3, 1905.
1048. Petauke. March 5, 1905.
1096. Petauke. January 1, 1906.

39. **Aparallactus lunulatus**, Peters.

1059. Ulungu Mountain, W. Loangwa. June 11, 1905.

40. **Elapechis niger**, Gthr.

1053. Mbala Country, East Loangwa District. May 6, 1905.

41. **Naia nigricollis**, Reinh.

1002. Near the Zambesi, Feira District. July 11, 1904.
1100. Petauke. January 6, 1906.

VIPERIDÆ.

42. **Causus resimus**, Peters.

1044. Petauke. February 21, 1905.
1046? Petauke. February 25, 1905.

43. **Bitis arietans**, Merz.

1034. Petauke. December 16, 1904.
1055. Mbala Country. May 17, 1905.
"Common, especially in the lower country. Native name 'Kapiri.'"

44. **Bitis gabonica**, D. & B.

1074 and one other. Ndola, near Kafue River, N.W. Rhodesia. October 11, 1905.

? ?

DESCRIPTION OF PLATES.

Figs. 1—5. Microphotographs by the author.

Figs. 6—9 and 11. Camera lucida drawings by Miss. K. H. Coward, B.Sc.

Fig. 10. Camera lucida drawing by the author.

Plate I.

Fig. 1. Transverse section of a small stem of *L. Hickii* × (11).

The pith with dividing walls in the cells is well shewn. It is surrounded by the ring of wood, the even contour of which is very characteristic of the species.

Numerous leaf traces are seen in the ill-preserved belt of parenchyma surrounding the wood.

In the south of the illustration is seen a stelar branch supplying a "Halonial" tubercle.

A 144. D. Watson collection.

Fig. 2. Transverse section of a rather larger branch of *L. Hickii* × (11).

In the S. and S.E. the "zone rayonnée" of the middle cortex is well seen.

The piece of xylem ring on the E. is becoming detached to form a branch to a Halonial tubercle.

A 170. D. Watson collection.

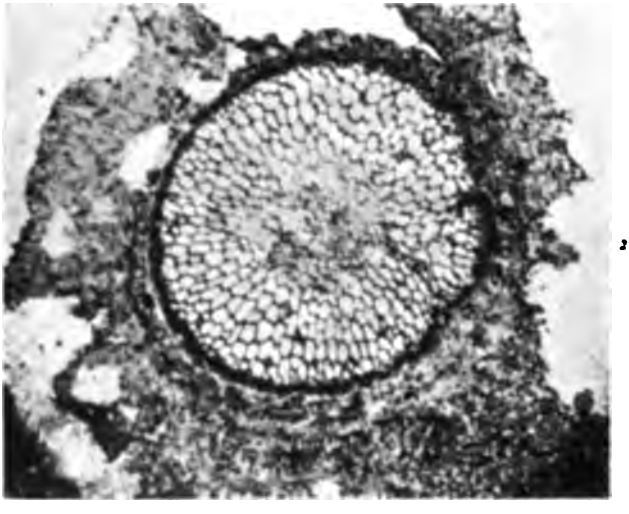
Fig. 3. Longitudinal section of external portion of the wood of a branch of *L. Hickii*, shewing origin of a leaf trace. × (190).

The bottom of the figure is occupied by the large scalariform tracheids of the metaxylem.

The leaf trace passes out to the N.E. corner of the figure.

A 201 F. D. Watson collection.

1



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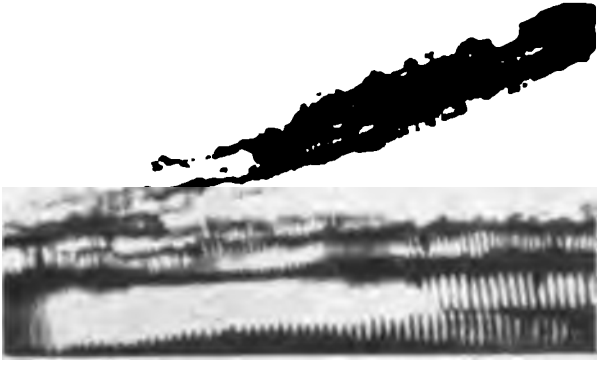

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Plate II.

Fig. 4. Almost radial section of a leaf base of *L. Hickii* × (30). The centre of the stem lies to the W.

The leaf trace is seen in the outer cortex, with the parichnos below it. The parichnos is also seen emerging to the leaf scar on the East.

The ligular pit is seen in longitudinal section and the dark tissue at its base and extending to W. over the leaf trace is transfusion tissue of short tracheids.

A 201 C. D. Watson collection.

Fig. 5. Oblique tangential section of an isolated leaf base, almost certainly belonging to *L. Hickii* × (30).

The patch of tissue around which transfusion tracheids are concentrated is the base of the ligule.

The two large patches of tissue, composed of stellate cells, are the two "pits" filled with aërenchymatous tissue in connection with the parichnos.

The parichnos itself is seen just within the west patch.

A 201. D. Watson collection.

Plate III.

Fig. 6. Portion of transverse section of *L. Hickii* represented i *Fig.* 1, shewing two leaf traces and the protoxylem point × (72).

A 144. D. Watson collection.

Fig. 7. Portion of the transverse section represented in *Fig.* shewing the beginning of periderm formation in the oute cortex. × (72).

A 144. D. Watson collection.

Fig. 8. Portion of transverse section represented in *Fig.* 1 shewing a leaf trace, with xylem, phloëm, and the darl patch of secretory tissue, and the parichnos (shaded) t the outside of it. × (61).

A 144. D. Watson collection.

Fig. 9. Portion of a transverse section of a branch of *L. Hickii* shewing the exterior of the wood, the badly preserve soft tissue surrounding it, and a leaf trace in the inne cortex. × (72).

A 171. D. Watson collection.

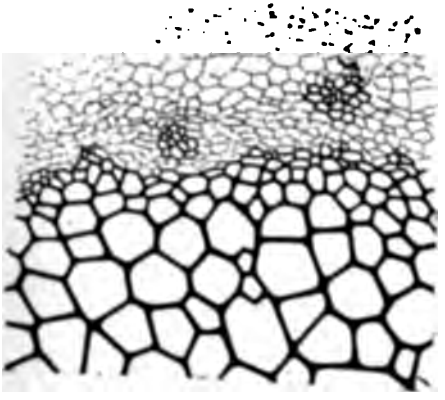
Fig. 10. A pair of sieve tubes with their companion cells, fron the phloëm of *L. Hickii*. × (324).

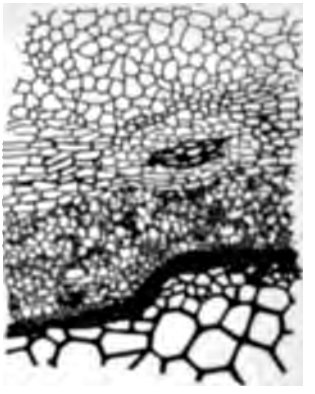
A 170. D. Watson collection.

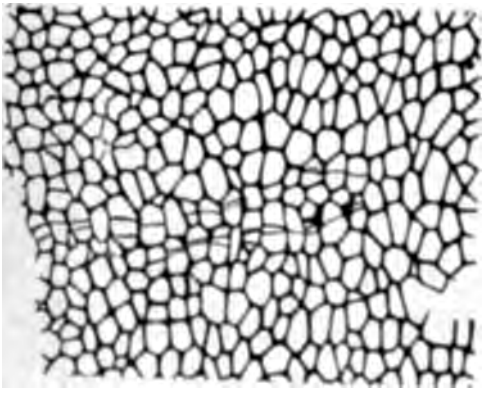
Fig. 11. Patch of Aërenchyma filling pit in a leaf base, still i connection with a stem of *L. Hickii*.

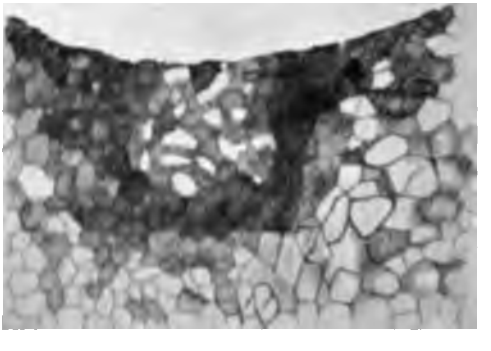
CN. 360*f*. Williamson collection.

All the figured sections are from the "Higher Early Bank Mine," at Hough Hill, near Stalybridge, in Cheshire, and ar from "coal balls," not from roof nodules.









Manchester Memoirs, Vol. li. (1907), *No.* **14**.

XIV. On the Compression of Gases by means of Hydraulic Apparatus.

By J. E. PETAVEL, M.Sc., F.R.S.

Received May 3rd, 1907. Read May 8th, 1907.

I. *On the Compression of Small Quantities of Pure Gas.*

In the course of experimental work it is occasionally desirable to compress small quantities of very pure gases. For this purpose the ordinary gas compressor is unsatisfactory. Not only is it difficult to obtain a compressor which will deal with less than a thousand litres at a time, but there always is a serious risk of contamination by a slight inleak of air, by admixture with the previous contents of the pipes and cylinders, and by the vapours given off by the heated leathers and stuffing boxes. A brief description of an apparatus for compressing a few litres of a pure or rare gas to a high pressure may therefore be of some interest.

The general scheme will be easily understood by reference to *Fig.* 1.

"*A*" is a glass bell jar of one or two litres capacity which is connected to the generating apparatus through the stopcock *a*, and to the compressing plant through the valve *b*. The liquid used in this gasometer is glycerine, which has a low absorbing power for most gases.

The compression cylinder *B* is of steel of about half a litre capacity. Its upper end is connected, as mentioned above, to the bell of the gasometer and also to the gauge *G* and storage cylinder *D*, the latter outlet being closed by the valve *e*. The lower extremity of this cylinder communicates on the one side with the hydraulic

pump *P*, on the other with the gasometer through the valve *f*.

As compared with the ordinary compression plant,* this apparatus has the advantage of simplicity, complete safety, and relatively low cost.

For the gasometer an inverted glass bell jar will be found convenient. It is connected to the compression cylinder and pump by rubber tubes. No motive power is required, and almost any form of hand-worked hydraulic pump can be used. The compression cylinder and storage cylinders are of weldless mild steel $\frac{1}{4}$ or $\frac{1}{2}$ inch thick according to the working pressure required, and can be obtained from the manufacturers who supply the commercial gas cylinders. The high-pressure valves and cone couplings are of the type previously described.† For connecting the various parts of the apparatus, flexible copper tubing of about $\frac{3}{8}$in. external diameter and $\frac{1}{16}$in. bore is employed.

With regard to the method of operating, a few words will suffice. The gas coming slowly from the generating apparatus passes through such purifiers as may be necessary, and accumulates in the gasometer. From time to time it is compressed into the storage cylinder in the following way:—

The valves *b* and *f* are first opened, allowing the gas to displace the glycerine contained in the compressing cylinder, they are then closed again and the valve *e* opened. The pump is now worked, forcing in the glycerine and compressing the gas. When the gauge indicates a pressure equal to that of the storage cylinder, the valve *g* is opened and the gas allowed to enter. To

* See R. S. Hutton and J. E. Petavel. *Journ. Soc. Chem. Ind.*, 1904, vol. 23, pp. 87—93.

† J. E. Petavel, *Phil. Trans.*, vol. 205, pp. 357—398.

avoid forcing over any liquid, the level reached by the glycerine in the gasometer when the cylinder *B* is full has been previously noted. The quantity of gas remaining in the compression cylinder can also be estimated by temporarily closing the valve *g* and noting the difference of pressure produced by a single stroke of the pump.

The system described above is convenient for dealing with gases which can only be generated at a slow rate—say, ten litres or less per hour—and pressures of 3,000 lbs. per square inch can easily be obtained with an ordinary hand pump.

II. *Compression of Gases to very High Pressures.*

The maximum pressure for which the ordinary type of two or three-stage gas-compressor can be successfully built is about three or four thousand lbs. per square inch. Above this limit, difficulties connected with the reduction of the clearance spaces, the efficient packing of the glands, pistons, etc., and the satisfactory cooling of the working parts become serious and are not easily overcome.

These troubles can be obviated by the use of hydraulic compression which has been successfully used by the author to compress gases up to ten or twelve thousand pounds per square inch.

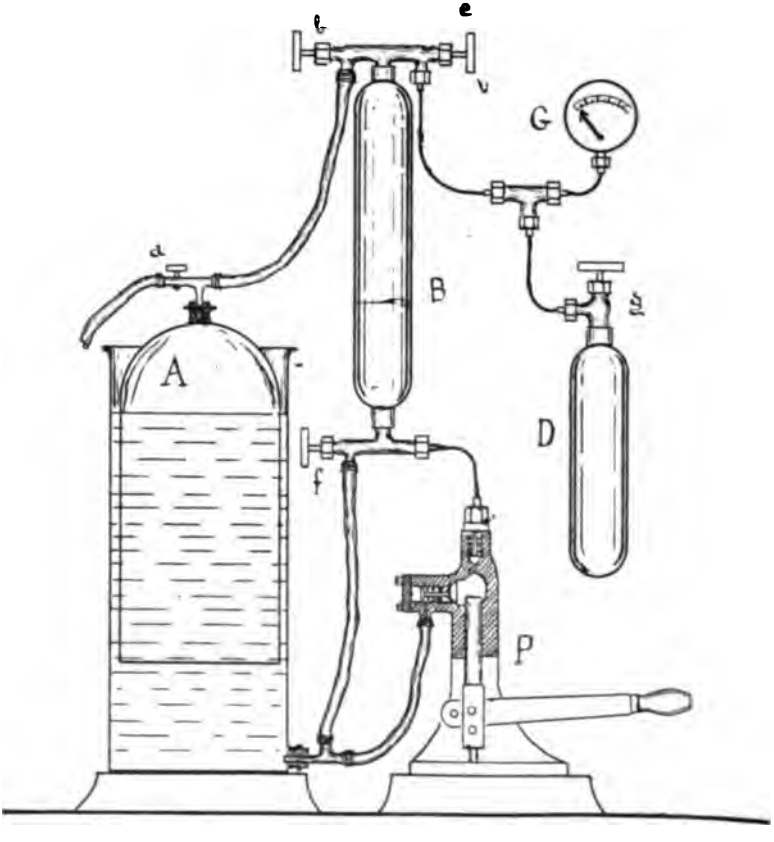
In principle the system differs but little from the one referred to above, but the apparatus is, of course, of considerably greater strength.

When working at these high pressures, it is convenient to eliminate the generating plant and gasometer, and to fill the receiver *B* with gas previously compressed and stored. The quantity of gas dealt with at each operation may thus be increased a hundredfold or more, and the amount of labour involved correspondingly reduced.

Where exceptional purity is of no great importance, the compressed gas for this purpose may be obtained commercially.

For all ordinary work a hand pump will be found sufficient, and, the contents of the receiver being compressed at a slow and uniform rate, no special provision is necessary for cooling the gas.

With regard to the question of safety, it is hardly necessary to point out the importance of securing the best materials and workmanship. Before use the apparatus should be carefully inspected and also tested hydraulically to double the working pressure.



Manchester Memoirs, Vol. li. (1907), *No.* **15**.

THE WILDE LECTURE.

XV. The Structure of Metals.

By J. A. EWING, M.A., LL.D., F.R.S.,

Director of Naval Education to the Admiralty.

Delivered February 15th, 1907.

I ought to apologise for bringing forward matter which cannot possibly be new to an audience acquainted with recent developments in various branches of science; but at least some part of the lecture may be unfamiliar, and in order properly to lead up to that I shall endeavour to state certain elementary facts about the crystalline structure of metals, although these are no doubt well known already by many of those now present. Without such a statement it would be difficult to show the relation between the facts as we have them and the comparatively novel theory which I am going to submit for your consideration. There is this further excuse, that what I have to say deals with matter in which I have had some little personal share in the way of original investigation, dating now from a good many years back.

At the outset, then, it is important you should realise that any metal, even the simplest and purest, is not by any means a single homogeneous thing, but is a great aggregate of distinct pieces which we call grains or granules. Those of you who are familiar with the Alps may know that if you examine the structure of a glacier, you find, taking any great block of ice such as may fall from a serac, that that block, when the sun plays upon it, gradually becomes resolved into pieces somewhere about

the size of a walnut or an egg. These pieces are separate crystals of water, and the whole thing is a grand aggregate of such separate granules, each granule a crystal in itself. Precisely the same thing is true of any piece of metal. It is true not only of cast metal, where one might readily expect it to be true, but it is true also of metal that has been forged or rolled, and what is more remarkable still, it is true even of a piece of iron which has been forged or rolled in the cold state. It is true also of so very different a type of metal as a sheet of lead such as is used for the covering of a roof. A sheet of lead is crushed enormously in the process of rolling; nevertheless if you take a piece from a roof and examine it, you find that it has the same general character. It is built up of a great aggregate of crystalline granules. To make this point clear I shall show slides which will allow us to trace some of the evidence by which this general deduction has been arrived at. When we polish and etch the surface of a piece of metal, and then examine it under the microscope, we are able to detect the existence of the various grains or granules of which the whole is composed. We can distinguish in the surface a difference of texture between one grain and another, and we can also distinguish clearly the boundaries between neighbouring grains. We may sometimes detect the difference between the grains in a metal which has not been polished or etched at all, as, for instance, when a smooth surface is formed by casting metal against a sheet of glass, but it is generally more apparent after the surface has been etched by the action of a dilute acid or some other solvent.

An example is shown in *Fig.* 1, *Plate I*, which is a photograph of the surface of a piece of wrought iron, etched by dilute nitric acid, and viewed with a magnifica-

tion of 100 diameters.* Notice the distinction in texture of the various grains, and the irregular boundaries between them.

In this example the microscope was looking directly at the specimen, of course, and the light by which the specimen was illuminated passed down through the tube of the microscope directly on to the specimen, perpendicular to the surface, and back again into the lens by reflection. But we can illuminate the specimen in a different way. We can throw upon it light from the side, and only a portion of the light dispersed by the different granules will be sent up into the microscope. When we do that we find a very striking difference in appearance. Here is an example (*Fig.* 2, *Plate II.*). It happens that this is a photograph of cast lead, but the difference between it and *Fig.* 1 is mainly an effect due to the oblique illumination. You see again the separate grains or granules with their boundaries, but you now find that some of them are very dark, others very bright, and others of intermediate shades. You also find when you move the light about, so as to make it fall first from one direction and then from another, and watch the same grains under the microscope, that a grain which is bright at one moment will be dark at the next, when the light is moved into a different position, and on the contrary, a grain which was dark before will turn out of an intermediate shade, or perhaps flash out quite bright. This becomes intelligible as soon as we consider of what it is that these grains consist.

We are accustomed to think of a crystal as a thing with well defined geometrically formed external boundaries. The grains that build up a piece of metal do not possess that characteristic, but for all that they are true crystals.

* Ewing and Rosenhain, *Phil. Trans.*, ser. A, vol. 193, p. 353, 1899.

They do possess what is really the essential characteristic of a crystal, that it is composed of an enormous number of elementary pieces, which we may call brickbats, in perfectly regular tactical formation. The essential thing about a crystal is, that in its own interior structure it should be composed of perfectly uniform pieces, which are placed together in uniform tactical formation, a formation to which a well drilled body of troops, or the flowers of an early Victorian wall paper, form a somewhat rough approximation. When we come to etch the grain we can detect very clear traces of such a regular tactical formation on the part of the elementary brickbats of which it is composed. Here (*Fig.* 3, *Plate I*) for instance, is a photograph showing what is observed in the microscope when the deeply etched surface of a particular metal is examined under a lens of high magnifying power. You can see quite plainly the traces of geometrical formation in the regular tactical grouping of the elementary plates or brickbats. When a structure of this kind is under the microscope, and is illuminated by light coming obliquely from one side, any one grain will reflect more or less light up to the lens, according to particular way in which its brickbats lie. Hence we find wide differences of brightness between grain and grain, but over any one grain the general brightness is uniform (as in *Fig.* 2, *Plate II*), because all the brickbats in any one grain face exactly the same way.

An even more striking example of the same thing is shown in *Fig.* 4, *Plate II.* Here the whole visible field is a portion of one grain of a steel containing four per cent. of silicon, which was studied by Mr. J. E. Stead. It lends itself particularly well to the exhibition of this structure. Note that the brickbats when etched do not appear to be of the same size; but, of course, the microscope does

not enable us to see individual brickbats; we are looking, so to speak, at fragments of masonry which the brickbats build up.

There are other lines of evidence which bring out clearly the crystalline character of the separate grains of metal. If you cast metal on to a smooth surface of glass, under some conditions of casting which are not very easy to reproduce, but which you sometimes have the luck to light upon, you find when you examine the surface that there are curious geometrical markings upon it which appear to be due to the presence of very minute bubbles of air or gas which are caught on the plate or perhaps have been occluded in the metal, and have come out in the process of solidification. These bubbles instead of taking a casual round formation, have a more or less distinct geometrical figure corresponding to the particular type of brickbat of which the crystal is built up. They are, as it were, hollow brickbats. They are holes representing the absence of certain brickbats in the surface of the metal.

Examples of this action are shown in *Figs.* 5 and 6, *Plate III*, which are photographs of a cadmium surface cast on smooth glass. *Fig.* 6 is part of a single grain only, with a very high magnification (over 4,000 diameters). These show in an unmistakeable way the geometrical character of the holes formed by tiny air bubbles, caught between the metal and the glass at the moment of solidification.

The crystalline markings which are a familiar sight on the free surface of a metal solidifying after being melted in an open dish, serve to show that in the growth of crystal grains the process goes on in a manner that is described as dendritic. That is to say the grain grows, as a tree grows, by spreading branches. These branches rush out in various directions, and then the intermediate spaces are filled up at leisure. Again, in the electrolytic deposit of

metal or in the crystallization of a salt from a solution (*Fig. 7, Plate IV*), you see these branches actually being formed. The process may be arrested before the intermediate portions are filled up, but if it is allowed to continue all the space would be filled up by the little brickbats, and then we should have a structure in all respects identical with that of the grains which are found in a solid block of cast or forged metal.

It may help you to think of the process as it actually occurs in a metal if you picture to yourselves a number of fairy children in a nursery provided with an unlimited supply of little brickbats of the same shape and size. Place the children in different parts of the nursery, give each of them an ample supply of brickbats, and let them all start building, not necessarily simultaneously (it does not matter whether they do so or not), but let each start building quite independently. Each places its first brickbat in some casual position without any reference at all to the position in which the other children are placing theirs, but once it has placed its first one it necessarily places all the rest strictly parallel to it. That is essential to the regular tactical formation of the crystal. Then imagine the process to go on until the whole space in the nursery is filled up. You will have each child's pile determined in size and shape only by this consideration, how big does it become before it is stopped by coming against the piles of its neighbours. That is exactly the process of crystal building as we have it in metals. It is casual differences in the rate of building one pile or another that determines the irregular boundaries of the grains. There is one further point to be mentioned. The children of our analogue are as aggressive as European powers in planting their flag in previously unoccupied territory. The crystals do not simply progress as solids,

they shoot out arms, seizing territory that they are afterwards going fully to occupy. These arms come out and meet and interlock, and then the places between are filled by a slower growth. The ultimate effect is to produce a solid block in which the skeleton formed by the original shooting out of the arms is completely merged. You may see the same kind of thing happen when a salt crystallises out of a solution on a glass plate. The different crystals are liable to become interlocked at their junctions by means of the arms shot out from each. It appears (as Rosenhain has pointed out*) that this interlocking is an important factor in determining the strength of a piece of metal. So far as the individual grain goes the strength depends upon considerations that we shall deal with presently when we come to consider the possible type of brickbat; but so far as the cohesion of one grain with another goes I think that it is in all probability due to an interlocking of the advancing arms. It may make this matter more obvious to you if I show an example of crystallisation in actual process. We will not attempt to crystallise a metal, because we could not satisfactorily show that by means of the lantern, but we shall crystallise a solution of a salt. I will take common ammonium chloride, and spread a film of saturated solution of that salt on a glass plate, and then put it into the lantern, and you will see the fairy children at work. You will see the little brickbats beginning to be apparent not only at one place but at many places on the surface of the glass. Crystallization starts not simply from one, but from many nuclei: arms are shot out: the crystals spread till they meet, and finally the whole surface of the plate becomes covered with a solid mass.

* Rosenhain, *Journ. Iron and Steel Inst.*, 1904, No. 1, p. 335.

We pass on now to another point which is of primary interest. How is it that with this crystalline structure in the grains a metal is capable of being plastic? We know, for instance, that if we stretch a bar of good iron, or, to take an extreme case, if we draw a piece of iron into wire, it is capable of being changed in form enormously without actual rupture. We can bend a plate or a bar, we can stretch it, we can draw it into wire, we can forge it cold into all sorts of shapes in virtue of the property of plasticity which has somehow or other to be reconciled with the fact that it is an aggregate of crystals. How do the crystals behave when the form of the metal is altered? Examine in the microscope a piece of iron which has been stretched until it has broken in the testing machine. You find that the crystal grains are there just as before, but they now have a predominantly long direction one way as compared with the other. Taking a general view over them, although they are very irregular in shape and size, you can easily see that they tend to be longer in the direction in which the piece was stretched. The meaning of that is, each individual grain has actually been extended in the direction in which the iron has been stretched as a whole. How is it that the crystal grain is capable of being extended, and how is it that the grain remains a crystal after such extension? Here (*Fig.* 8, *Plate IV*) is a very striking example which shows that it does remain a crystal. This is a microphotograph from the cross section of a bar which was drawn down in the cold state from one inch in diameter to half-an-inch in diameter. That means a very severe straining of the iron, nevertheless the grains remain crystal grains. The particular crystal, a part of which is shown in this field, has been bent round into a shape resembling that of a horse-shoe, but all over it there are

little geometrical pits produced in the process of etching, which upon close examination turn out to be true rectangular pits, with sides which have parallel directions all over the crystal.

Examine it under a high power, and you find these geometrical markings parallel to one another, showing that there still is a true crystalline structure within the grain. How has that crystalline structure been preserved? Mr. Rosenhain and I, in the course of an investigation carried out some years ago in Cambridge, found that the straining of the individual grain took place much as a pack of cards is strained when you make one card slip over another.

This was observed by watching an individual grain under the microscope in a piece of iron. When it is strained a number of markings appear on it, in the form of lines, more or less straight and parallel, which appear dark under the microscope. A close examination shows on any severely strained crystal two, and in some cases three, systems of such lines.

Mr. Rosenhain and I called these lines "slip-lines," because they are lines formed by a process of slipping. They run, in a general way, parallel, and then there is another system, or it may be two systems, crossing them, running in other directions. As you pass from one grain to another you find the grains distinguished by differences in the directions of the slip lines. *Fig.* 9, *Plate V*, shows slip-lines as they manifest themselves in a piece of cast lead, after it has been subjected to a process of straining. Over each crystal of lead no fewer than three distinct and separate systems of lines can be plainly seen.

To understand what these lines really are, consider an imaginary section (*Text-fig.* 1) through a couple of grains of metal. The line on the top represents the surface at

which we are supposed to be looking. *AC*, *CB* are the surfaces of the two grains and the boundary between them comes down from *C* into the interior of the metal. We suppose that the piece is stretched by applying a pull which acts in the direction *AB*. This causes a slip in each grain, but it is not a homogeneous slip occurring throughout the whole grain. It is a disconnected slip which

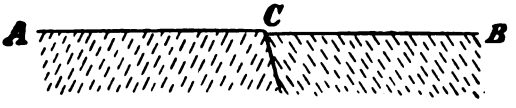


Fig. 1.

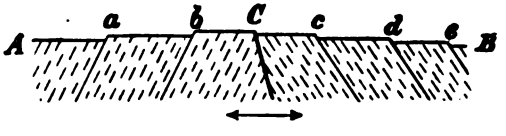


Fig. 2.

occurs at a series of places lying a little way apart and it has the effect of producing steps by lowering one part of the surface relatively to another, as the lower figure (*Text-fig.* 2) illustrates. Imagine what happens when you look down through the microscope on this surface. These little sloping steps at *a*, *b*, *c*, *d*, and *e* are dark, because the light coming down upon them is not reflected back into the microscope, but is thrown away to the side; consequently everyone of these steps forms a dark line.

As soon as Mr. Rosenhain and I realised that these lines were little steps, we also realised that by choosing a suitable direction for the light to fall upon the specimen, namely, from the side instead of the top, it might be possible to show them up as bright lines when all the rest of the specimen was dark. Think of the light (in *Text-fig.* 2) as coming in from the side, striking one of those sloping

steps, and being thrown into the microscope. That step, and the other steps on the same grain parallel to it, would then seem bright instead of dark, while the rest of the surface would, of course, seem dark, because it throws none of the light up into the lens. By changing the direction of the incident light you can get one or other strained crystal to show its lines as bright lines; and always when one line in a crystal becomes bright the other lines forming a parallel system with it flash into brightness at the same time, thereby giving a most satisfactory proof that the lines are in fact due to the presence of strictly parallel steps, which are explained by slips that have occurred in the process of straining. It is to these slips that plasticity is due. In *Fig.* 10, *Plate V*, you have under high magnification an example of the slips in a crystal of strained lead, which has altered its form by slips taking place in three independent sets of planes, and the photograph shews well the regularity and the independent character of the successive slips.

Mr. Rosenhain* has continued this investigation, and has devised a very ingenious further proof, if any were needed, of the character of these lines. He took a piece of iron which was severely strained, and he deposited copper electrolitically upon its polished surface. According to the theory I have just given you the surface of a strained piece of iron is really not a plane surface any more, but is composed of a series of steps. He deposited copper in order to demonstrate the existence of these steps. Then he cut the piece across at right angles to the surface, and polished both the iron and the copper, and the polished section clearly shows the little steps as serrations in the line dividing iron from copper.

Connected with this subject is a matter of very great

* *Jour. Iron and Steel Inst.*, 1906, No. II., p. 189.

practical importance, namely, the fatigue which occurs in metal when we expose it to repeated variations of strain. To take an experimental laboratory example, suppose we have a rod fixed in a thing like the mandrel of a lathe, which is caused to revolve, and let the rod be loaded at its extremity by a weight or by the pull of a spring balance. This causes it to be bent, and the surface is being compressed and extended alternately at every half revolution of the rod. You may cause this to revolve thousands or millions of times, and what you find is that it will ultimately break under the action of a bending force which would be perfectly safe if the rod were standing still. In other words, if there is repeated alternation in the strain, then the metal suffers what is technically called fatigue, and this fatigue may lead to rupture under many repetitions of the straining action.

The nature of this fatigue manifests itself when the piece is examined under the microscope. Watch an individual crystal in the surface of the bar, and at first you may not detect any effect. After a few thousand reversals you may just begin to see the appearance of slip-lines; with more reversals these increase in number and in visibility, and finally, after some hundreds of thousands of reversals, the piece breaks. The process of fatigue is associated with the gradual development of more and more prominent slip-lines in the piece which is undergoing alternations. Mr. Humfrey and I showed that what actually happens is that some of these slip lines develop into cracks, and when a crack starts it rapidly spreads from crystal to crystal, and at last there is a sudden rupture.*

I will now ask your attention for a short time to a molecular theory which I have endeavoured to formulate

* Ewing and Humfrey, *Phil. Trans.*, ser. A, vol. 200, p. 241, 1902.

by way of explaining the process of crystal building, and the characteristics which the crystal exhibits under strain.* Just think of the various things that these brickbats have to explain. In the first place, they have to explain the regular tactical formation in the crystals; next they have to explain cohesion; then they have to explain how the metal is elastic, that is to say, how it can undergo a certain small amount of strain without any permanent set, with complete recovery of its original form when the stress is removed; next they have to explain how, when it is further strained, it passes an elastic limit, and how it is capable of plastic strain, undergoing permanent set and giving rise to dissipation of energy; finally, they have to explain those various phenomena of fatigue I have just briefly touched upon. The molecule or individual brickbat that I imagine the crystal to be built up of is a piece which has three axes of polarity. Think of it as having six poles, with a pair of opposite poles at the ends of each of the three axes, and the axes at right angles to one another.

The polarity is not magnetic, although we may conveniently represent it in a model by means of magnetism. Whatever the polarity is due to, you must suppose that a

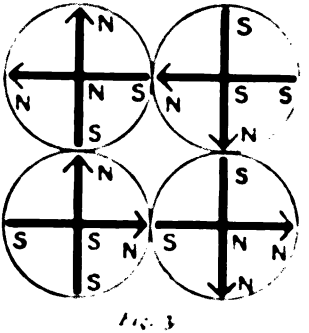


Fig. 3

* *Report Brit. Ass.*, York, 1906. Address of President, Section G.

pole in one brickbat attracts an opposite pole in another, and that two like poles will repel, and two unlike poles will attract. Suppose now the crystal to be built by a gradual assemblage of such polar molecules. Begin with one, and put down others, one by one, in the position

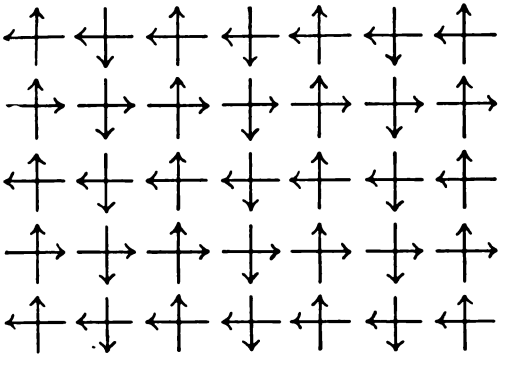


Fig. 4.

of greatest stability with respect to it. By the time you have put down four molecules, they have taken the positions shown in *Text-fig.* 3. And similarly *Text-fig.* 4 shows the arrangement that is found in a much more numerous group, when the condition of maximum stability is satisfied in the process of crystal building.

I want next to show you the establishment of what I shall call a little group of dissenters. I use that description merely as a short term to express a group, the members of which keep each other in countenance, but are out of complete harmony with their environment. We can establish such a group by supposing two of these molecules turned round. They are still stable, but not so stable, and not so comfortable, as they were to begin with. *Text-fig.* 5 shows such a dissenting group at *a*, *b*, *c*. Their position may be strengthened by turning one or more other molecules, such as *d*, round, so as to join

forces with them. The dissenters give one another mutual support. We can suppose their little community enlarged

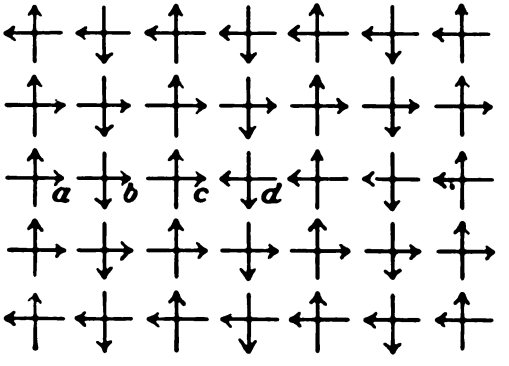


Fig. 5.

as much as we please, but it still remains different from the rest of the crystal.

The matter will become clearer if we study experimentally a model in which polar molecules are pivotted on centres on a glass plate, so that their shadows may be thrown on the screen, and you can watch how they behave under the action of their mutual forces.

Begin crystal building with two molecules, and notice how they accommodate themselves to one another first of all. This, if you like, is the settlement from the liquid state. You see there is a little hesitation at first. Four of them have now taken up the same position as the four shown in the drawing (*Text-fig.* 3.) That is the position of most stability, and if we were dealing with a small community they would necessarily take up this position. If I displace them from it you will see that they return to it. Now we will take a group sufficiently large to have a dissenting community set up in it. You see that at first the whole group is in proper tactical formation corresponding to complete stability—the formation namely of

Text-fig. 4. Now notice how I establish a community of two dissenters. They are just keeping one another in countenance and no more. They have very little stability indeed. But now I increase the number of dissenters considerably, and the stability of the dissenting group is clearly strengthened.

If you have a dissenting group set up in any way, they are likely to show that they are different from the rest when you come to etch the metal. They are less stable than the rest, and consequently one may anticipate that they will be more readily attacked by any etching re-agent. Probably that is the explanation of those geometrical pits which we see when we etch the polished surface of forged iron. It is an interesting point that when you come to etch an iron surface, even although the rest of the iron is scarcely attacked at all, here and there the iron is so strongly acted on that a hole is formed, which has a well-defined rectangular shape. I imagine that hole was originally a dissenting community which has yielded to the acid more readily than the rest. To that extent the crystal was imperfect: the condition of absolutely uniform tactical grouping was not rigorously fulfilled; for a dissenting group introduces a want of homogeneity within the grain in which it occurs, the general nature of which will be apparent when one compares *Text-fig.* 5 with the perfectly regular tactics of the preceding figure.

Passing from that, I want to show you how this theory allows us to explain the characteristics of straining. First of all, it is quite obvious that a crystal of this sort is capable of transmitting any elastic disturbance. Let us displace one particular molecule by turning it some way round, and letting it go suddenly. You see that in swinging back it starts a wave which is transmitted

gradually all over the group. To show next that this theory is in harmony with what we know about elastic straining and non-elastic straining, we will take a group of molecules in two portions, separately mounted on two glass plates, which can be caused to slide past one another.

Notice what happens when I make one portion of the "crystal" slip past another portion. Up to a certain point there is nothing in the nature of permanent strain. If you watch the molecules which are adjacent to the line of slip, you will see that they are striving, as it were, to hold together. That corresponds to elastic straining. In any strain causing distortion, you can imagine slipping to take place to an infinitesimal extent on any number of planes on the crystal, and on any one of these planes you simply have a slight displacement of the neighbouring molecules, a slight turning of the neighbouring polar axes, but without breaking bond. Suppose we cause the strain to be more violent, the bonds will be broken, and the molecules will swing round into new positions. There will be dissipation of energy, and there will be no recovery; in other words there will be permanent set. In the model you see this dissipation of energy, when one of the plates is caused to slide so far past the other as to break the molecular bonds. The molecules swing round into new positions, and the energy which they thereby dissipate is lost by its being spread throughout the substance of the piece, and probably spent in generating internal electric currents. That is a non-elastic strain as I conceive it.

Notice too the effect of periodic straining in opposite directions many times over, which we imitate in the model by making one of the glass plates slide a little way backwards and forwards repeatedly past the other. This

see-saw sets up a large amount of movement in the adjacent molecules, and sets up dissenting communities which spread themselves on both sides of the plane of slip ; so that not only molecules immediately adjacent to the plane of slip are affected, but molecules extending for some distance inwards on both sides. An interesting confirmation of this is given by the fact (noticed by Rosenhain) that after you have fatigued a piece by repeated straining backwards and forwards, and then polish and etch it, you find a marking which recalls the presence of slip lines, although you have a perfectly fresh etched surface to examine. This means that the metal has really had a difference in structure set up in it by the repeated alternations, a difference in structure which is sufficient to manifest itself in the etching. That difference, I believe, is due to a corresponding permanent disturbance of those molecules which are adjacent to the planes in which slip has occurred.

The time is too short for me to attempt a complete account of all the points which are explainable by this theory. I will only mention one more. Overstraining causes a species of fatigue in a metal which shows itself conspicuously in a loss of elasticity. After this fatigue has been set up it is possible, by means of rest cure, to restore the elasticity which has been lost. It is a well-known fact, that if you take a piece which is beginning to be fatigued, and give it a rest, it recovers, and you can accelerate that recovery very much by raising the temperature, as, for example, by such treatment as dipping it into hot water. There is a remarkable instance of this in a practice that is probably familiar to many now present, when you dip a razor into hot water after stropping it. The stropping of a razor means the alternate bending of the edge to one side and the other. That

causes fatigue, which leaves the edge of the razor after stropping in a comparatively soft and non-elastic condition. In the language of the theory I am putting forward to-day, it leaves the edge of the razor composed very largely of dissenting communities. These dissenting communities tend to resolve themselves with mere lapse of time into conformity. I do not know why it should be so. Possibly the disturbance caused by heat, even at the ordinary temperature of the air, produces enough movement of the molecules to tend at least to break up those feebly stable groups and restore them to the original tactical formation. Anyhow the fact remains that fatigue is recovered from slowly in this way, and you can enormously accelerate the recovery by dipping the razor into hot water. Thus the theory explains a piece of domestic practice which for a long time was so unintelligible that I for one was not inclined to believe that the hot water had any value at all. Experiments made on bars of steel in the testing machine in my laboratory by Mr. James Muir demonstrate this recovery very clearly.* It occurs slowly at ordinary temperatures, but a quick restoration can be effected by the application of sufficient warmth.

Just one other point before I close. A good many years ago I showed that the facts of magnetic quality could be explained by supposing that iron and other magnetic metals had molecules which were capable of being rotated, these molecules being possessed of permanent magnetic polarity, and being free of all constraint except that which is due to their natural magnetic forces. The process of magnetisation consists in turning these molecules round so that they tend to face more or less one way, and the iron becomes saturated when they all

* Muir, *Phil. Trans.*, ser. A, vol. 193, p. 1, 1899.

face exactly one way. How does that agree with the views I am placing before you now? In the first place the polarity we are now dealing with—the polarity that has to do with crystal-building—is not a uni-axial polarity as the other was. It is a polarity along three independent axes. In the second place this polarity is not a magnetic polarity at all, because the application of magnetising force does not cause the brickbats composing the crystals to revolve. Consequently we must suppose that the molecule is really a much more complex thing than these models would seem to show. We must suppose that in addition to this polarity along three axes, which determines the position of the brickbat among its neighbours in the crystal, there is in addition a uni-axial polarity which is capable of being rotated with respect to the other. In other words, we must think of the molecule as having its three axes capable of being held fixed in space by the neighbouring molecules, and at the same time possessing some sort of internal structure that is capable of being turned round so as to get the magnetic axes to point one way without interfering at all with the orientation of the molecule as a whole.

Fig. 1.

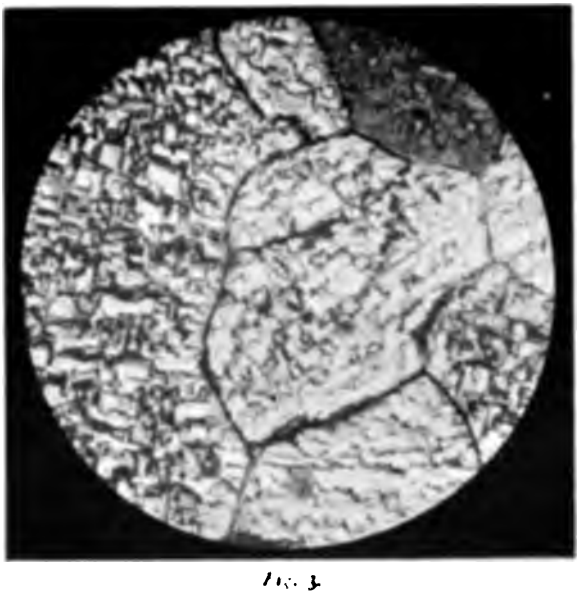


Fig. 3.

Fig. 3.

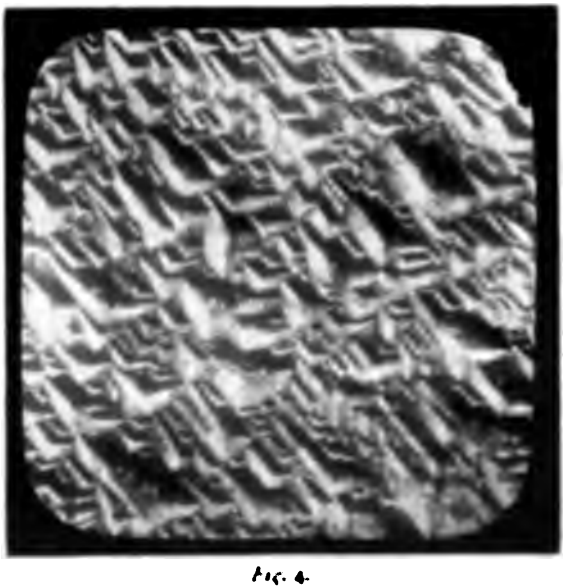


Fig. 4.

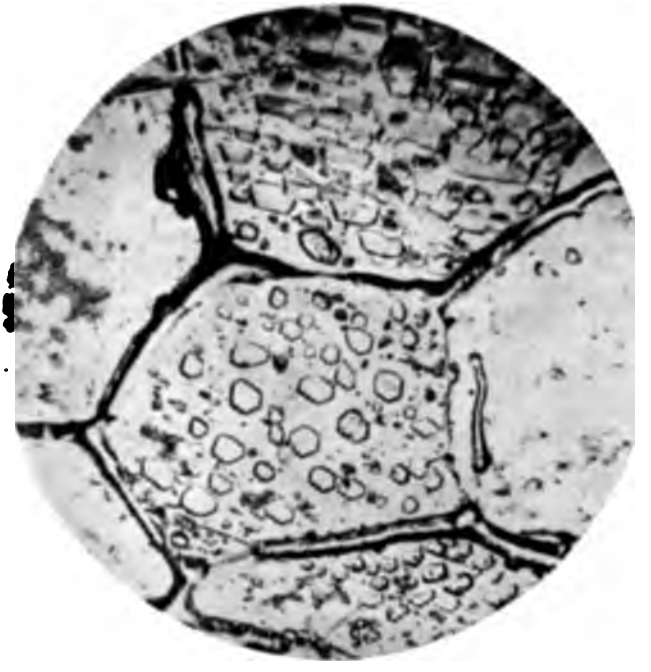


Fig. 5.

Fig. 7.

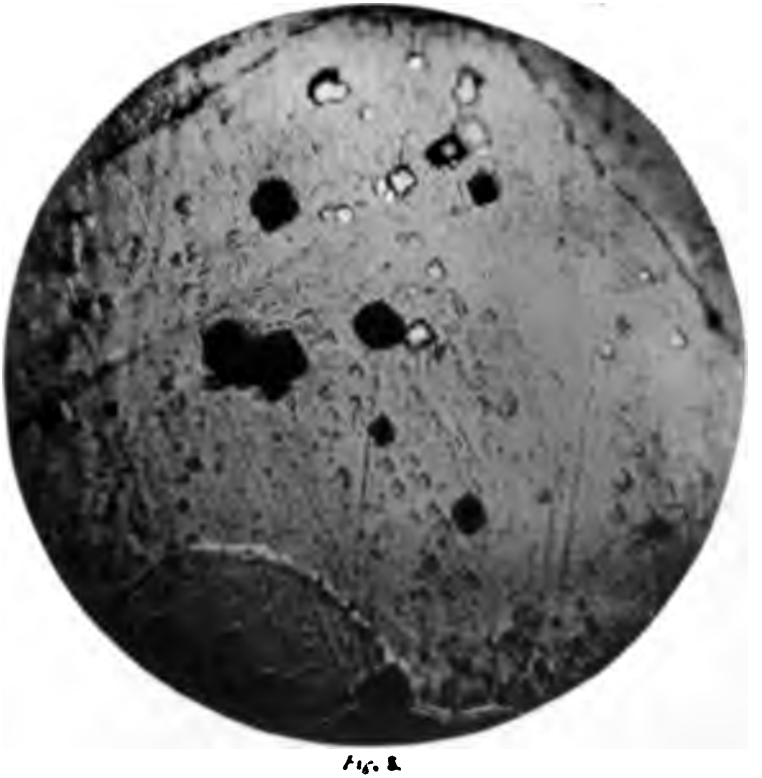


Fig. 8.

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XVI. Some Tables for illustrating Statistical Correlation.

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It was not my original intention to preface the description of my new Tables with an account of Weldon's experiment.* But I was persuaded that without such an account the meaning of my Tables would not be evident to many. It must be understood, therefore, that except in the matter of presentment the first part of this paper makes no claim to originality.

The second part contains an account of an interesting extension of the experiment described in the first.

I.

Let us begin at the beginning, so far as we can. In the case of a very great number of vital phenomena we are unable to predict exactly what the result of certain events will be. We know that they will fall within certain limits, but where within those limits we cannot tell. We believe that a duck will not produce a duckling with a beak as narrow as a snipe's, but the exact breadth of the beak—measured, let us say, in terms of its length—in a given instance, we cannot foretell.

If these words ever happen to lie before the eyes of a biologist, the chances are that he will be inclined to ask me, "What *does* it matter what the length-by-breadth index of a duck's bill is?" My answer to this interruption is

* :06. Weldon, W. F. R. "Inheritance in Animals and Plants," pp. 81—109, in "Lectures on the Method of Science." Edited by T. B. Strong. Clarendon Press, Oxford, 1906.

that so long as we are as much in the dark as we are at present about the circumstances which may affect an animal's or plant's chances of attaining maturity, any statement that such and such a feature matters or does not matter is unwarrantable.

But let us return to our argument. Some living things are variable. We may adopt two attitudes towards this variability; we may either say that it does not matter and ignore it, or we may suspect that it may matter and measure it. In my opinion evidence does not justify us in adopting the former attitude. Statisticians have provided us with a method for measuring this variability. But we usually want to know more than this; we want, if possible, to measure the closeness of the relation between two such variable things. Statisticians have again provided us with a method which enables us to measure the closeness of that relation in which biologists are most interested, namely, that between parents and children.

The first step in this method is to construct a Correlation Table. How this is done is best explained by giving an account of Weldon's beautiful experiment. The variable phenomenon he dealt with was the number of dice, in a throw of 12, which fell so that faces with 4 or more pips on them were uppermost. When we throw a single die it is an even chance whether it falls so that a face with 3 or fewer pips on it lies uppermost, or whether a 4-or-more-bearing face lies uppermost. Therefore the most probable number of dice with faces bearing 4 or more uppermost in a throw of 12 is 6, but the number may be anything between 0 and 12 inclusive, though these extreme results occur very seldom. Here is a list shewing the frequency with which the 13 possibilities occurred in a thousand throws which I have made:

Result of Throw.	Frequency.
0	0
1	3
2	15
3	55
4	110
5	208
6	223
7	179
8	129
9	64
10	11
11	2
12	1

Imagine that I am before you and that I have 12 dice in a dice-box. I shake it and throw them. The result happens to be 7 dice with 4-or-more-bearing faces uppermost. I pick up all the dice, put them back into the dice-box, shake it and throw them again; the result happens to be 5 such dice. What I want you to observe is that in this pair of throws the two throws which compose it are absolutely independent of one another; the result of the second is not affected by the result of the first; a knowledge of the result of the first does not help us to predict the result of the second.

Let us think of some way of making the two throws in such a pair dependent, of making the result of the second affected by the result of the first, and of bringing it about that a knowledge of the result of the first shall help us to predict the result of the second.

I suggest to you that a good way of doing this is to leave half the dice, which formed the first throw, lying on

the table, and allow them to form half of the second throw. If I do this the second throw will consist of six dice lying exactly as they did in the first throw and of six dice thrown afresh. Six of the twelve results which determine the total result of each throw will be common to the two throws of a pair.

But you will say, "How will you know which six dice to leave on the table. You will not be able to help leaving the ones showing 4-or-more down and picking up the others, except by making it a rule not to do so. And that would introduce too much complication. It seems to me that it will be very difficult to make the decision as to which dice shall be picked up and which not, a matter of chance and not of choice." This objection is quite reasonable, but the difficulty is not insurmountable. All that is necessary is to make six of the dice different from the other six. This is easily effected by leaving them for a few hours in red ink. It does not matter whether we make it our rule to leave the red or the white dice down on the table when we gather up the six dice to make the second throw. Let us decide on the red.

We can now start to make a pair of connected throws, in which the decision as to which dice pass over undisturbed from the first to the second throw is a matter of chance and not of choice. I put all the dice—the 6 red and the 6 white—into the dice box, shake it about and throw the dice on to the table. The result happens to be 6.* Now I gather up the white dice, put them into the dice box and throw them. In describing the results of the second throw I count the red as well as the white, although only the latter have been thrown a second time. So that half of the results which determine the

* The number describing the result of a throw means the number of dice exhibiting faces with four-or-more pips on them uppermost in that throw.

total result of the first throw are exactly the same as half of those which determine the total result of the second. The two throws are connected together. For instance, let us consider the maximum possible difference between the two connected throws and compare it with the maximum possible difference between two independent throws such as we started by making. The maximum possible difference between two independent throws is twelve. A 12 may follow a 0. Or a 0 may follow a 12.

But in the case of two connected throws the maximum possible difference is 6. It may happen by all the red dice showing 4-or-more and all the white ones 3-or-less in the first throw and by all the white ones showing 4-or-more when thrown again (that is, by a 12 following a 6); or by all the dice showing 3-or-less in the first throw and the white ones all showing 4-or-more when thrown again (that is, by a 6 following a 0). The number of ways in which the maximum difference between the two throws may be attained is given by the number of pairs of figures that follow. The first figure in each pair indicates the result of the first throw in that pair; the second that of the second. 0-6, 1-7, 2-8, 3-9, 4-10, 5-11, 6-12, 7-1, 8-2, 9-3, 10-4, 11-5, and 12-6. The essential point is that 6 is the maximum possible difference.

But you see how seldom it is likely to occur. It depends on *all* the white showing the opposite kind of face uppermost in the second throw to those which they exhibited in the first. The fact that it does not occur often, however, does not concern us now. What concerns us at present is that the maximum possible difference between the result of a pair of throws connected in the way we described above is 6, whilst that between two unconnected throws is 12. The two results in the 'connected' pairs are, as it were, chained together. We may compare the two results in

I.II.	I.II.	I.II.	I.II.	I.II.	I.II.	I.II.	I.II.
5·3	9·9	9·8	3·2	3·7	7·7	5·8	7·8
6·7	4·6	2·4	8·5	8·7	5·4	3·4	7·7
7·5	7·9	5·3	9·7	6·6	4·2	6·7	5·5
6·7	6·8	4·6	7·7	7·5	6·8	6·7	7·7
4·8	5·7	5·6	5·4	9·5	5·4	6·10	9·7
4·7	4·6	6·4	7·6	4·8	6·7	8·7	8·7
5·6	4·2	3·6	6·6	6·5	6·7	7·7	5·4
7·4	6·7	9·8	8·9	7·5	5·4	5·6	6·9
7·7	6·7	7·8	6·7	2·5	8·4	7·8	5·6
7·9	7·7	5·5	6·5	5·7	3·5	9·5	7·7
5·7	9·10	5·4	9·5	4·4	6·4	7·6	4·5
6·8	6·3	9·9	5·3	5·8	6·10	8·8	6·7
8·7	5·4	8·4	5·4	7·6	3·2	4·6	7·7
3·3	8·8	8·8	3·3	5·7	9·8	3·4	7·3
7·6	5·5	5·9	6·7	5·5	7·10	6·5	7·9
6·5	8·10	5·5	3·5	6·6	8·6	5·6	5·5
3·5	8·6	6·4	6·8	6·3	5·5	4·8	8·8
6·7	3·7	3·4	4·6	6·4	7·4	4·6	4·3
5·7	5·7	6·4	5·6	7·7	4·5	5·5	6·6
6·5	6·9	8·5	3·4	6·6	4·7	8·6	5·7
4·3	8·6	7·6	7·6	4·3	6·5	5 7	4·6
8·8	5·7	8·7	5·6	9·7	6·6	6·4	7·5
5·7	5·7	5·8	5·4	6·7	6·6	4 4	9·10
6·8	6·6	7·5	5·6	6·4	4·5	7·5	9·8
9·6	8·8	5·6	8·8	6·9	8·8	9·8	5·7
7·6	6·6	7·6	6·5	8·6	4·3	6·6	5·6
8·6	6·7	5·6	6·6	6·6	7·7	6·7	6·7
4·2	4·6	7·6	8·7	6·2	8·6	4·5	6·8
3·5	8·7	5·5	8·6	7·7	4·5	5·7	7·7
6·6	7·6	8·6	6·8	2·5	7·5	5·5	4·2
5·8	1·4	8·6	5·6	6·5	9·6	5·7	2·4
4·9	8·7	8·8	9·7	5·5	7·6	6·5	5·7
7·7	5·6	6·6	10·7	4·5	5·4	5·6	6·4

I.II.	I.II.	I.II.	I.II.	I.II.	I.II.	I.II.	I.II.
5·5	4·5	4·3	7.6	7·7	7·7	4.8	8.7
8.7	4·5	5·5	4·2	7.8	5·7	5·5	10.7
9.8	9.8	7·7	5·7	6.8	4·7	9.6	4.6
4·3	7.6	6.6	8.8	5·7	8.9	6.5	7·7
8.8	5.8	5·7	7·7	5·5	7·7	8.8	6.7
10.9	4.8	6.7	8.7	5·4	5·5	4·7	
5·5	7·5	4.6	9.9	4.6	2.2	6.5	
5·5	8.7	6.7	8.7	6.3	6.7	5.6	
8.6	5·5	6.7	9.8	4.7	7·5	10.9	
6.5	5.8	5·4	6.4	7·9	6.5	5.5	
6.5	8.7	6.5	3·3	4·4	6.4	11.8	
6.5	7.6	6.5	4·5	4.6	8.9	4.8	
4·4	5.6	7.8	8.10	9.8	7·5	8.7	
7·7	5.8	7.6	5·5	8.6	6.8	8.8	
8.9	8.7	4.6	3·7	6.8	6.7	6 5	
7·3	7.8	5·2	6.6	5·4	8.5	7·7	
6.3	5·7	9·7	9.6	7.8	7·5	4·5	
5·2	5 4	4·5	6.8	6.9	6.5	6.5	
6.8	8.5	6.8	8.7	5.8	6.6	9.9	
7·7	8.8	6.8	4·3	4·7	7.10	4·6	
7·5	7·7	5.8	6.6	8.10	1.2	6.4	
5·7	2.6	4.6	7·7	10.8	3·7	6.8	
6.6	5·7	7·7	5·4	6.10	4·7	6.5	
7.8	6.6	6.4	5·7	6.4	6.4	3·7	
6.6	6.5	3.5	6.6	7.6	4·4	5·7	
5 8	6.6	5·3	8.5	7·7	9·7	6.7	
8.7	5·7	3·4	4·4	9·9	1.3	8.7	
8.7	3·5	5.6	5·3	4·4	5·4	5·4	
5.6	7.8	5.8	8.7	7.8	5·5	7.8	
6.5	6.5	2.5	8.5	3.6	5·9	7·3	
8.9	5·5	7·5	8.6	4·4	6.3	7.8	
6.8	8.7	6.7	6.6	3.7	4.6	5.6	
6.5	9.6	8.5	6.7	4·3	2.6	5·5	

unconnected pairs to a couple of dogs, not chained together, in a show stall at a dog show. Let us imagine the stall to be twelve feet long and each foot to be marked on the base of its frontage so that, as you stand looking at it, the left boundary of the stall is over the 0 and the right over the 12. The two dogs could, if they wanted, lie as far away from each other as the size of the stall permitted, namely one over the 0 and the other over the 12. We may compare the two results in 'connected' pairs to two dogs in such a stall leashed together by a six-foot chain. If one of them wishes to sleep over the 0 the other has to lie in the middle of the stall over 6 If after a time the latter insists on moving to 12 the former must put up with 6. And similarly with intermediate positions. This parallel illustrates only the maximum possible difference between first and second throws in 'connected' and 'unconnected' pairs. To find a parallel for the most usual difference between first and second throws in connected pairs we should have to imagine the leash connecting the dogs to be made of a piece of elastic with a maximum stretch of six feet.

We must return to the dice. Let us make a number of pairs of such connected throws, and see what the result is. On pages 6 and 7 are given the results of 500 such pairs. The Roman numerals at the top of each column mean that the left-hand figures give the results of the first throws; the right-hand ones those of second throws.

The list does not show very much in this form. If you look through it you will find that a high number is as a rule followed by a fairly high one, and that a low one is usually followed by a fairly low one. But this is not presented at all vividly to the eye. What we want is some means of finding out, without the labour of counting through the whole series, the number of times a given

result in a first throw is followed by a given result in a second. This want is supplied by the so-called Correlation Table. Here is one on which are exhibited the results of the 500 pairs of throws detailed on pages 6 and 7.

Second Throws.

First Throws.	0	1	2	3	4	5	6	7	8	9	10	11	12	
0														
1			1	1	1									3
2			1		2	3	2							8
3			2	3	5	6	2	6						24
4			5	9	8	11	16	7	6	1				63
5			2	5	17	24	19	25	11	2				105
6			1	5	14	25	24	24	17	4	3			117
7				2	2	13	16	27	12	4	2			78
8					2	7	13	22	14	5	3			66
9						3	5	6	9	5	2			30
10								2	1	2				5
11									1					1
12														
			12	25	51	92	97	119	71	23	10			500

The Table proper is bounded at the left and top by single lines, and at the right and bottom by double ones.

It is made up of 169 squares. A horizontal series of these squares is spoken of as a row; a vertical series of them as a column. So that we may say that the table consists at once of 13 horizontal rows, each of which is made up of 13 squares; and of 13 vertical columns, each of which is likewise made up of 13 squares.

The numbers at the top of (but outside) the columns stand for the various possible results of second throws, which, as we know, may be anything from 0 to 12. The

numbers at the left-hand end of (but beyond) the rows have the same signification, except that they refer to first throws.

At the base of (but below) most of the columns are numbers, which signify the number of times the event, indicated by the figure at the top of the column, happened in the 500 second throws. For example, a 2 occurred 12 times; a 3, 25 times; a 4, 51 times; and so on. At the right hand end of (but beyond) most of the rows are numbers which signify the number of times the event indicated by the figure at the left of the row happened in the 500 first throws. For example, a 1 occurred 3 times; a 2, 8 times; a 3, 24 times; and so on.

So far, we have only referred to the figures outside the table, and I hope I have made clear to you what they mean. Now, we must turn our attention to the table itself. It will be found that the numbers at the bases of the columns are the sums of the numbers in the columns above them; and that the numbers at the right-hand ends of the rows are the sums of the numbers in the rows to the left of them. Each column intersects all the rows, and each row intersects all the columns of the table. Every square is part both of a column and of a row.

What is the meaning of the numbers in the squares? The figure in any square gives the number of times the result indicated by the number at the left-hand end of the row of which it is a part happened in a first throw, and was followed by the result indicated by the number at the top of the column of which it is a part, in the second throw. For example, starting with the top row we see that there was not a single case of a 0 thrown at all in these 500 pairs of throws. Coming to the second row we see that there was one case of a 1 in a first throw followed by a 2 in the second; one of a 1 in a first followed by a

3 in the second, and one of a 1 followed by a 4. Examination of the third row tells us that there was one case of a 2 followed by a 2, two of a 2 followed by a 4, three of a 2 followed by a 5, and two of a 2 followed by a 6. And so on throughout the table.

The best way to familiarize yourself with the construction of such a table is to make one for yourself from the figures on pages 6 and 7. You draw a correlation table like the one we have been examining, but quite blank; and write the numbers 0 to 12 along the tops of the columns, and at the left-hand ends of the rows just as in that table. The plan is to indicate the result of a pair of throws by putting a dot in one of the squares of the table. But which square? We shall see in a moment. The first pair of throws on the list is a 5 followed by a 3. The figure 5, denoting the result of the first throw, tells us in what row the dot must be. The figure 3, denoting the result of the second throw, tells us in what column the dot must be. The square, therefore, formed by the intersection of this row by this column is that in which the dot must be placed. The next pair of throws is a 6 followed by a 7. We find the position of the square in which the dot representing this result is to be placed in the same way. We continue this process until all the pairs on the list are entered; then we add up the dots, and write the totals thus obtained, in each square; add up the figures in each square composing a column, and write the total at its base; and add up the figures in each square composing a row, and write the total at its end. The result is the correlation table on p. 9.

There is one feature of it which cannot fail to attract your attention immediately. It is that the figure-containing squares lie diagonally across the Table. It is not very difficult to see what this means. It is the

expression of a fact we already know, namely, that low numbers are associated in a pair with low numbers, high ones with high ones, and intermediate ones with intermediate ones.

We are now approaching the outskirts of a vast subject. The task I set myself was to shew you the way to it; but not the way into it. Having given you an account of Weldon's device for illustrating correlation, I will go no further, but will leave you in the hands of the statistician, who, I may perhaps tell you, will provide you with a means of working out from such a Table a number called the *correlation coefficient*, which is a measure of the degree of connection between the two things you are dealing with. In the case of the dice throws connected in the way we have just been considering, this number will be approximately ·5 In the case of Table 0 (p. 15) it will be approximately 0; in the case of Table XII., (p. 21) approximately 1. In fact, quite generally, if m dice are left down in the 12 the coefficient is m/12ths.

II.

Weldon's experiment may be varied in the following way. Instead of staining 6 dice red and leaving the six red dice of the first throw on the table to form half of the second throw, we may stain some other number, say 9, and allow 9 dice to pass over from the first to the second throw. In fact we may stain and leave over from the first to the second throw any number of dice from 0 to 12 inclusive. Table 0 shows the result of 500 pairs of throws in which, to make the second throw in each pair, all the dice were gathered up from the table and thrown again. In this case there is no correlation between the two throws. Table I. shows the result of 500 pairs of

throws, in which to make the second throw, all the dice except one were gathered up from the table and thrown again. In this case there is very slight correlation between the two throws. To make Table II., 2 dice were left down. To make Table III., 3 were left down. And so on.* To make Table XII., it did not matter whether the dice were stained red or not, for the second throw was merely the first throw counted over again. And the Table consequently shows any given number in the first throw always followed by the same number in the second.

Each of the thirteen Tables which are seen on the Plate, was made by substituting for the Arabic numerals in each square of Tables, 0 to XII., a corresponding number of dots, and then in erasing all the lines inside the four boundary lines of the Table.

The attempt to make the phenomenon of correlation clear to an audience, previously unfamiliar with it, is in my belief less likely to be successful if it is only possible to show one Table such as VI., instead of a series of Tables exhibiting at a glance the gradual increase in correlation as shown by the transition from a circular blur to a diagonal line, as seen in the Plate. The reason for this is the same as that which would make it very difficult for any one to explain that the angle which the two arms of a 'governor' on an engine make to one another, becomes obtuse in proportion as the speed of rotation becomes great, if he lived in a world in which 'governors' always travelled at a constant rate such as would keep the two arms at a constant angle of 90 degrees to each other. Table VI. might convey nothing to the mind of anyone regarding it even after he had read the first part of this paper. But a cinemato-

* I am indebted to Mr. Charles Beddolph for making all the throws except those which compose Tables 0, VI., and XII.

graph, the successive pictures composing the film of which were the successive dot-Tables on the Plate, would show movement resulting from known causes. Cause, 'no dice left down' has effect 'circular blur.' Cause, '12 dice left down' has effect 'diagonal line.' Cause, '6 dice left down' has effect intermediate between last two effects.

Imagine that you have a small model of a 'governor.' If you do not touch it the arms hang down. If you spin the axis as fast as you can, the arms lie in the same straight line. Spin it at a moderate rate; the arms make an angle of 90 degrees to each other.

Directly we can play with machinery we can see how it works. Movement and change enable us to perceive and to understand.

The two squares intersected by diagonal lines in Table I. are squares in which from the conditions of the experiment a throw cannot fall. In the rest of the Tables, the same is true of all the intersected squares and of all the squares to that side of the intersected ones remote from the diagonal of the Table.

TABLE 0.

	0	1	2	3	4	5	6	7	8	9	10	11	12	
0														
1						1			1					2
2				1		4				1				6
3				1	4	7	8	5	4	1	1			31
4			4	4	7	9	6	12	5	5				52
5			3	5	13	26	14	14	12	6	1	1		95
6			1	6	15	25	24	28	15	6	2	1		123
7			1	5	7	16	22	15	13	6	1		1	87
8				1	7	15	19	12	6	6				66
9		1		1	2	9	7	6	6		1			33
10					2		1	2						5
11														
12														
		1	9	24	57	112	101	94	62	31	6	2	1	500

TABLE I.

	0	1	2	3	4	5	6	7	8	9	10	11	12	
0														
1														
2						2	3	2		1				8
3		1		1	4	4	5	8	4	2				29
4		1		2	3	10	11	6	8	5	2			48
5		1		9	11	13	15	22	11	6				88
6			2	5	8	40	25	32	8	7	1	1		129
7				7	8	13	14	14	14	9	3			82
8			1	2	7	9	2	10	13	2	2	1		59
9					5	3	8	12	7	5				47
10						1	1	3	1	2				8
11					1				1					2
12														
		3	3	26	47	102	94	109	67	39	8	2		500

TABLE II.

	0	1	2	3	4	5	6	7	8	9	10	11	12	
0														
1						1								1
2				2		1								3
3			2	2	4	7	7	3						25
4				5	7	7	19	10	4	5				57
5		1	4	3	10	20	26	21	9	3				97
6			1	3	6	30	26	18	11	6	2	3		106
7			1	2	12	13	15	17	30	3	3			96
8		1	1	4	8	7	10	16	10	6		1		64
9				2	6	2	9	8	6	2				35
10						2	1	3	4	2				12
11							1	1		1				3
12						1								1
		2	9	23	53	91	114	97	74	28	5	4		500

TABLE III.

	0	1	2	3	4	5	6	7	8	9	10	11	12	
0														
1					1		1							2
2							6	1						7
3		1	1	5	2	2	4	5						20
4			1	8	6	21	16	6	6					64
5			4	3	12	15	23	22	9	3	1			92
6		1		10	16	17	23	28	22	5	1			123
7			1	4	9	17	18	24	16	5	3			97
8				1	5	6	10	14	8	7	2	1		54
9					4	3	9	6	6	2				30
10						1	1	1	4	3				10
11								1						1
12														
		2	7	31	55	82	111	108	71	25	7	1		500

TABLE IV.

	0	1	2	3	4	5	6	7	8	9	10	11	12	
0														
1					1	1								2
2			1	1	1	2	1	1						7
3			2	4	3	4	5	2						20
4			1	2	8	18	8	12	6	1	1			57
5			3	8	16	16	19	21	7	5	2			97
6		1	1	5	19	25	25	20	12	2				110
7			2	1	6	22	17	32	17	12	3			112
8					5	6	16	18	14	7	2			68
9						3	2	6	5	2				18
10							3		2	2				7
11								1	1					2
12														
		1	10	21	59	97	96	113	64	31	8			500

TABLE V

	0	1	2	3	4	5	6	7	8	9	10	11	12	
0														
1					1	1								2
2			3	1	5	1	1							11
3			3	3	8	4	4	4						26
4			5	6	9	21	14	10	5	1				69
5				4	11	23	21	15	9					83
6			1	3	9	18	27	29	16	3	2	1		109
7			1	2	5	14	24	28	10	7	4			95
8				1	5	9	10	18	14	4	2			63
9						2	4	13	4	3				31
10					1		2		2	3	1	1		10
11								1						1
12														
			11	20	54	93	112	118	60	21	9	2		500

TABLE VI.

	0	1	2	3	4	5	6	7	8	9	10	11	12	
0														
1			1	1	1									3
2			1		2	3	2							8
3			2	3	5	6	2	6						24
4			5	9	8	11	16	7	6	1				63
5			2	5	17	24	19	25	11	2				105
6			1	5	14	25	24	24	17	4	3			117
7				2	2	13	16	27	12	4	2			78
8					2	7	13	22	14	5	3			66
9						3	5	6	9	5	2			30
10								2	1	2				5
11									1					1
12														
			12	25	51	92	97	119	71	23	10			500

TABLE VII.

	0	1	2	3	4	5	6	7	8	9	10	11	12	
0														
1				1										1
2			1	2	4	2								9
3			4	2	6	5	4	3						24
4			1	7	10	19	13	8	1					59
5			1	5	16	14	24	14	2	1				77
6				3	13	17	28	22	9	4	1			97
7				1	3	15	26	40	18	8	2			113
8						8	14	16	16	12	3			69
9						2	3	10	10	9	4			38
10							4	2	3	2		1		12
11							1							1
12														
			7	21	52	82	117	115	59	36	10	1		500

TABLE VIII.

	0	1	2	3	4	5	6	7	8	9	10	11	12	
0														
1														
2			4	2	3	2								11
3			2	8	9	7	4							30
4			3	1	12	20	9	5	2					52
5				4	21	30	26	13	4					98
6				4	12	30	36	19	10	7	1			119
7				1	1	15	29	27	13	7	1			94
8						1	8	19	13	10	1			52
9						1	1	4	13	5	5	3	1	33
10								1	3	3	3			10
11									1					1
12														
			9	20	58	106	113	88	59	32	11	3	1	500

TABLE IX.

	0	1	2	3	4	5	6	7	8	9	10	11	12	
0														
1			1	1										2
2			2	5	1	1								9
3				5	7	3	1							16
4			1	8	18	19	5	1						52
5				6	17	30	32	13	1					99
6				1	10	18	34	26	10	1				100
7					4	17	26	30	18	7				102
8							7	28	16	11	5			67
9							3	6	15	9	7	1		41
10								1		4	3	2		10
11											1		1	2
12														
			4	26	57	88	108	105	60	32	16	3	1	500

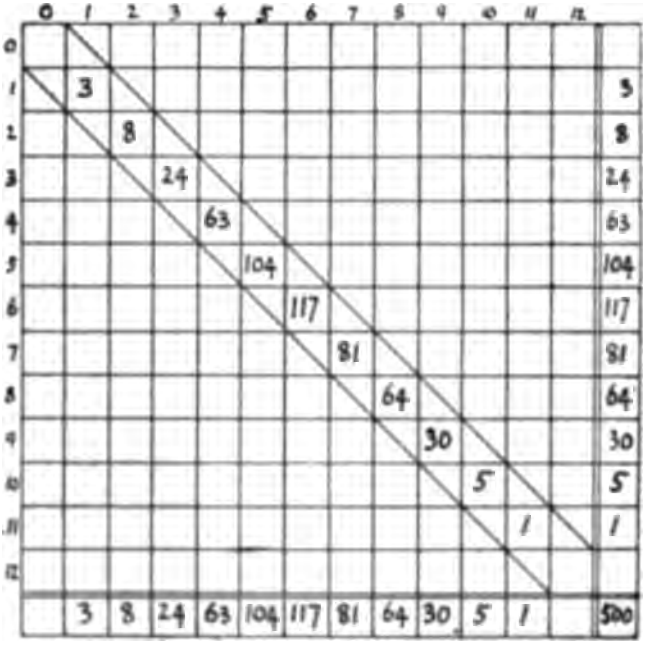
TABLE X.

	0	1	2	3	4	5	6	7	8	9	10	11	12	
0	1													1
1		1												1
2			2	5										7
3		1	3	8	9	3								24
4			2	10	18	19	6							55
5				1	24	43	32	10						110
6					4	22	37	24	6					93
7						6	27	39	19	5				96
8							9	17	24	9	1			60
9								10	14	11	7			42
10									1	6	2	1		10
11											1			1
12														
	1	2	7	24	55	93	111	100	64	31	11	1		500

TABLE XI.

	0	1	2	3	4	5	6	7	8	9	10	11	12	
0														
1														
2			5	3										8
3			2	7	10									19
4				7	21	23								51
5					19	44	33							96
6						22	56	30						108
7							31	49	16					96
8								25	38	13				76
9									15	18	5			38
10										1	5	1		7
11											1			1
12														
			7	17	50	89	120	104	69	32	11	1		500

TABLE XII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3 5
8 8
24 24
63 63
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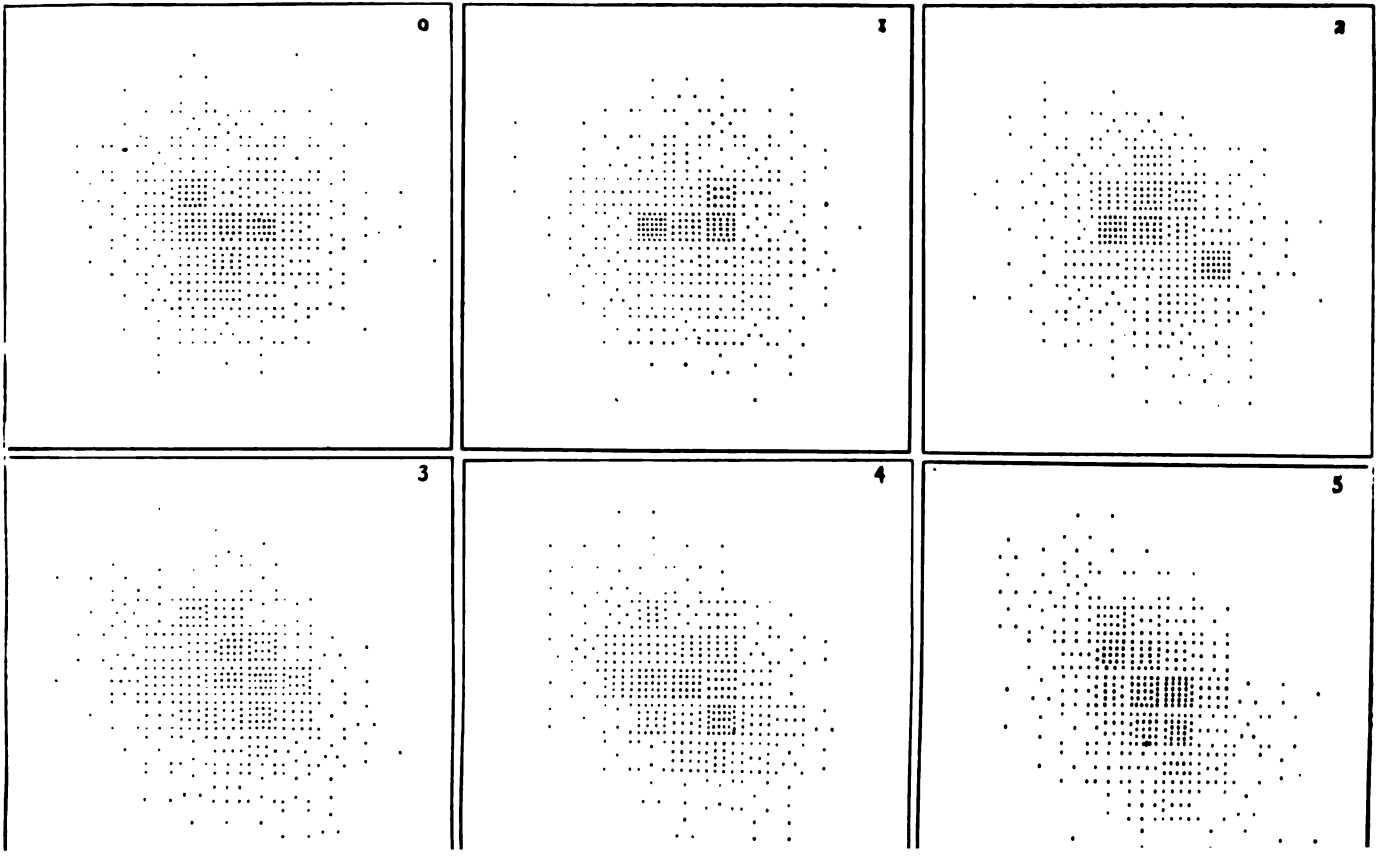
117 117
81 81
64 64
30 30
5 5
1 1
3 8 24 63 104 117 81 64 30 5 1 500


0
1
2
3
4
5

PROCEEDINGS

OF

THE MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, October 2nd, 1906.

Dr. W. E. HOYLE, F.R.S.E., in the Chair.

The thanks of the members were voted to the donors of the books upon the table. The following were among the recent accessions to the Society's Library:—"*The Beaufort Scale of Wind-force*," by G. C. Simpson (4to., London, 1906), "*The Life History of Surface Air Currents*," by W. N. Shaw and R. G. K Lempfert (4to., London, 1906), presented by the Meteorological Office; "*De Java-oorlog van 1825-30*"...Vierde Deel, [by] E. S. De Klerck (8vo., Batavia, 1905), "*Rapporten van de Commissie in Ned.-Ind. v. Oudheidkundig onderzoek op Java en Madoera, 1904*" (4to., Batavia, 1906), presented by the Bataviaasch Genootschap van Kunsten en Wetenschappen; "*Bestimmung der Längendifferenz zw. d. grossh. Sternwarte bei Heidelberg u.d. Kaiserl. Univ.-Sternwarte in Strassburg i. E.*," von E. Becker u. W. Valentiner (4to., Karlsruhe i. B., 1906) presented by the Astronomische Institut bei Heidelberg; "*Report on the Geodetic Survey of part of Southern Rhodesia*," by A. Simms (fol., Cape Town, 1905), presented by the Royal Observatory, Cape of Good Hope; "*Les Prix Nobel en 1903*" (8vo., Stockholm, 1906), presented by the Académie Royale Suédoise des Sciences; "*Catalogue of the Molière Collection in Harvard College Library*," by T. F. Currier and E. L. Gay (8vo., Cambridge, Mass., 1906), presented by Harvard College Library;

"*Reports to the Evolution Committee*," iii. (8vo., London, 1906), presented by the Royal Society; "*The Bristol Museum and Art Gallery...1772-1906*," by W. R. Barker (8vo., Bristol, 1906), presented by the Committee of the Bristol Museum; "*India*," by P. Loti, transl. by Dr. G. A. F. Inman (8vo., London, [1906]), presented by Mr. Ben Walmsley; "*Antiquities of the Jemez Plateau, New Mexico*," by E. L. Hewett (8vo, Washington, 1906), presented by the Bureau of American Ethnology; "*The Argument, a priori, for the Being and the Attributes of the Lord God, the Absolute One, and First Cause*," by W. H. Gillespie, 6th ed. (8vo., Edinburgh, 1906), presented by the Trustees of Mrs. H. Gillespie.

Professor F. E. WEISS, D.Sc., F.L.S., read the following paper, entitled "**Gutta percha from a Chinese Tree** (*Eucommia ulmoides* Oliver)."

With the increasing use of indiarubber and gutta-percha in various industries, it seems important to draw attention to plants capable of yielding these valuable vegetable products, which are not as yet being used as sources.

To these belongs the Chinese Tree (*Eucommia ulmoides* Oliv.), of which Dr. A. Henry sent some specimens to Kew about the year 1890. According to Dr. Henry's account, the tree was highly valued on account of the medicinal qualities of its bark, and largely cultivated in China. It appears to be a native of the mountainous districts of Hupeh and Szechuan. This plant, which up to that time was unknown to botanists, was described by Prof. D. Oliver ('90) as *Eucommia ulmoides*, and the material at his disposal being somewhat fragmentary the plant was provisionally placed by him in the tribe Phyllantheae of the Natural Order Euphorbiaceae. An examination of flowering specimens which arrived some years later (1894) from China caused its transference to the Trochodendraceae,* a small family of plants, containing only four genera, all of Asiatic origin.

* See Engler & Prantl, "Natürliche Pflanzenfamilien, Nachtrag," p. 159. 1897.

In his original description of Eucommia, Prof. Oliver drew attention to the extraordinary abundance of "elastic gum in all the younger tissues, excepting perhaps the wood proper—in the bark, the leaves and petioles and pericarp ; any of these snapped

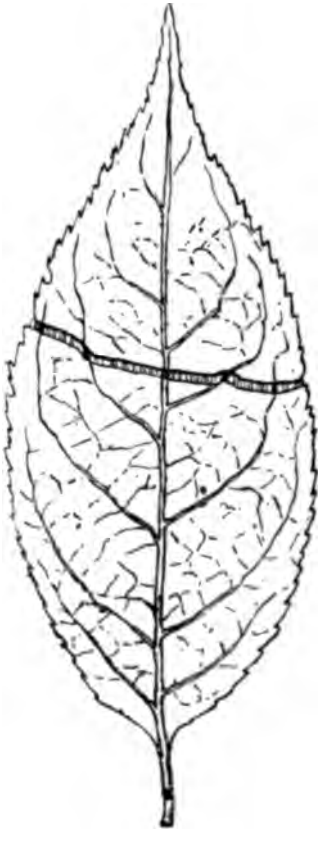


FIG. 1.—Actual size.

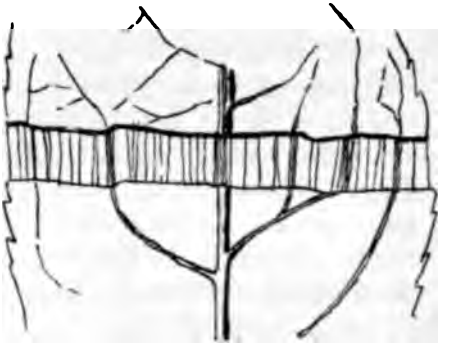


FIG. 2.—Portion of leaf enlarged to show clusters of threads occurring at veins.

across, and the parts drawn asunder, exhibit the silvery sheen of innumerable threads of gum." (*See Figs. 1 and 2.*)

When two years later some spirit material of this interesting plant was sent home by Dr. Henry, I was able to make an

examination of the cells containing these glistening threads ('92), and found them to be long unbranching cells, originating in pairs in the cortical tissues, and penetrating thence into the neighbouring parts, in the case of the stem, largely into the secondary bast. The fact that the threads are insoluble in alcohol, in acids, and in alkalies, while swelling up in ether and dissolving in chloroform, together with other reactions, led me to the conclusion that they were not of the nature of gum, but probably some form of caoutchouc or rubber such as is found in the milk-containing cells (latex cells) so characteristic of the family of Euphorbiaceae in which the plant had been placed by Prof. Oliver.

When some years later Messrs. Vilmorin, Andrieux & Co., of Paris, had imported some living plants of Eucommia, a re-investigation by Messrs. Dybowski and Fron ('99) resulted in establishing the fact that the elastic threads did not consist of caoutchouc, but of the allied substance gutta percha, which agrees with rubber in many of its chemical and physical properties. A striking difference, however, is the fact that when gutta percha is placed in hot water it can be moulded, and whatever shape is given to it is retained when it becomes cold.

Gutta percha is derived mainly from a tree known as *Dichopsis gutta* (Benth. and Hooker), formerly placed in the genus Isonandra. This tree, known to the Malays as "Taban Merah," is a native of the East Indies, and possesses a milky juice or latex containing the gutta. To obtain it the tree is generally felled and stripped of its bark from which the latex flows out with some difficulty, often accelerated by beating. From the coagulated latex the gutta percha is obtained by a process of purification, consisting largely of boiling it in water.

Of course the felling of trees for this purpose is a very destructive method, and seriously endangers the sources of supply. Besides this, only a portion of the gutta is obtained, and that contained in the leaves more particularly is lost. If the leaves of the gutta-percha tree are broken asunder, elastic

filaments are seen of the same kind as those shown in Eucommia, the gutta percha having become solidified. (*See Figs. 1 and 2.*)

Many attempts have been made to extract this solid gutta from the leaves, as they contain about 9 or 10% (Obach, '99) of this useful substance, and if the whole of it could be extracted the yield would be about 20 times as great as that of the tree trunk, which is sacrificed in the native process. For plantations of gutta-percha trees this would, of course, be of the greatest importance.

But the various methods suggested and patented for extracting gutta percha from leaves* unfortunately produce a substance which is of less value than the natural product. The chemical processes seem in some way to alter some of its properties, and the gutta percha obtained by chemical means is less lasting, especially when exposed to air and light. This is possibly due to the fact that the gutta is deprived of some of the resinous substances with which it is mixed in nature.

Any process which proves successful with the leaves of the gutta percha tree proper should be equally applicable to Eucommia. Indeed, Messrs. Dybowski and Fron have applied the procedure recommended by Jungfleish, which consists in extracting the gutta with toluene, but the yield seems to have been much smaller than in the case of the Dichopsis, only 2·25%. The bark, however, is richer than the leaves, and when I experimented with some dried bark in 1892 I obtained a yield of about 3 per cent.

Gutta percha has been obtained from a few other trees, notably from the Balata tree (*Mimusops ballata*), another member of the Sapotaceae, but though more readily obtained, because the latex is more liquid and can be easily obtained by

* Eng. Pat. Spec. 4252, March 1892, Dieudonné Rigole.
,, ,, ,, 11166, June 1892, Sérullas.
,, ,, ,, 654, Jan. 1896, ,,
,, ,, ,, 17936, July 1897, W. Ramsay.
,, ,, ,, 19406, Aug. 1896, Obach.

tapping the tree, the gutta percha is less valuable as it is mixed with a larger amount of resinous material.

The special interest in Eucommia lies in the fact that unlike the other gutta yielding plants it is capable of growing in a temperate climate. A native of the mountainous regions of China, its foliage is deciduous, and it can stand a fairly severe winter. Messrs. Vilmorin have grown it in the open for some years near Paris, and at Kew it has been successfully grown in the Botanic Gardens. Its appearance here is more of the nature of a large shrub than a tree. I have now two plants in my garden at Withington, and they are in a very healthy condition.

Should the methods of extraction of gutta percha become more perfected, and a means be found to counteract the defects of the product so obtained, there seems no reason why some of our waste land should not be made to produce this substance for which there is a growing demand, and the natural sources of which are becoming year by year reduced.

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WEISS, F. E. ('92). "On the Caoutchouc containing cells of *Eucommia ulmoides*." *Trans. Linn. Soc. London*, vol. 3, part 7, 1892.

"Gutta Percha from a Chinese Tree." *Bulletin of Miscellaneous Information, Royal Botanic Gardens, Kew*, 1901.

Mr. C. GORDON HEWITT, B.Sc., read a paper entitled "**A Preliminary Account of the Life-History of the Common House Fly** (*Musca domestica* L.)."

General Meeting, October 16th, 1906.

The President, SIR WILLIAM H. BAILEY, in the Chair.

Mr. HERBERT THOMAS HOLMES, M.A. (Cantab.), *Eastnor, 77, Wellington Road, Heaton Chapel*, was elected an ordinary member of the Society.

The President gave notice that, as the result of the ballot taken on the suggested alteration of the hour of the Evening Meetings of the Society, which was 62 for 6 o'clock and 12 for 6-30, he would move, at the next General Meeting, the following resolution:—

"That in future the time of commencement of the Evening Meetings of the Society be changed from Half-past Six to Six o'clock."

Ordinary Meeting, October 16th, 1906.

The President, SIR WILLIAM H. BAILEY, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

The PRESIDENT exhibited and presented to the Society a framed enlarged photograph of the Statues of Dr. Dalton and Dr. Joule in the entrance hall of the Manchester Town Hall.

The communication standing in the name of Mr. R. L. TAYLOR, F.C.S., F.I.C., having been withdrawn, an account was given of the following paper: "**A Development of the Atomic Theory which correlates Chemical and Crystalline Structure and leads to a Demonstration of the Nature of Valency,**" by WILLIAM BARLOW, F.G.S., F.C.S., and Prof. W. J. POPE, F.R.S.

The primary object of the work now described was to derive an explanation of the numerous crystallographic relationships which exist between chemically related substances and which have not hitherto been embraced by any theoretical scheme. It was found, however, on formulating and developing the very simple fundamental conception stated below concerning the environment of the atoms composing a chemical molecule, that, not only is the relation between the chemical constitution and crystalline form of any compound quantitatively indicated, but chemical valency is clearly demonstrated to be a simple volume relationship. The fundamental conception is the following:—

Each chemical atom present in a compound occupies a distinct portion of space by virtue of an influence which it exerts uniformly in every direction. The domain of the chemical molecule is the space-unit, consisting of one or more of these distinct portions of space, obtained by homogeneously subdividing into units a homogeneous structure built up of the spheres of influence of a number of associated atoms. The form of aggregation of the spheres of influence of the atoms thus associated in a molecule constitutes the stereometric arrangement of these atoms, and thus the chemical molecule acquires a definite shape. A crystal is the homogeneous structure derived by the symmetrical arrangement in space of an indefinitely large number of spheres of atomic influence.

In order to embody this conception and its developments in a concrete form, balls of definite sizes are employed to represent the spheres of influence of the different atoms, and close-packing of these balls in various symmetrical arrangements is resorted to. For the purpose of making models which accurately express the

facts soft indiarubber balls are used, and the assemblages built up from them are compressed until the interstitial space is practically eliminated. This compression does not materially alter the relative dimensions of a close-packed assemblage of elastic spheres as measured between the sphere centres; the equilibrium of the mutual interactions of the elastic deformable spheres of the artificial system represents an equilibrium between attraction and repulsion such as has been usually postulated by molecular physicists. The definite magnitude of sphere used in the case of a given element does not represent the absolute atomic volume of the latter. It stands for the relative atomic volume as compared with the atomic volumes of other elements present in the same compound; this relative volume is found to be almost constant throughout series of allied compounds.

The development of the above conception of molecular constitution leads to the conclusion that in a crystalline structure the component spheres of atomic influence form a homogeneous and close-packed arrangement, that is, a homogeneous arrangement in which, if hard undeformable spheres are employed, the maximum number of contacts and the minimum proportion of interstitial space occurs. Further, it is found that in homogeneous close-packed assemblages of the elastic spheres of various sizes, one particular kind of component sphere may be homogeneously replaced throughout the assemblage by other spheres, the total volume of which is equal to that of the displaced spheres in such a way that close-packing is re-established by the occurrence of a slight shear or distortion of the assemblage. It thus appears that the volumes of the spheres of influence of the atoms composing a molecule are approximately directly proportional to the chemical valencies of the component atoms.

It therefore follows that if, in a series of chemically related crystalline substances, the axial ratios, $a:b:c$, and the interaxial angles, α, β and γ, have been suitably selected, the relative molecular dimensions, $x:y:z$, or the "equivalent parameters," are simple functions of the crystallographic dimensions and the sum of the valencies of the atoms composing the molecules.

The latter quantity, W, is termed the "valency volume," and the equivalence parameters are:—

$$x = \sqrt[3]{\frac{a^3 W}{c \sin\alpha \sin\beta \sin\gamma}} \qquad y = x/a. \qquad z = cv.$$

As an indication of the value of the method of calculation here indicated may be shown the simple interpretation which it affords of the long known, but hitherto unexplained, crystallographic relations existing between the so-called humite minerals, namely:—

Chondrodite, $Mg_3(SiO_4)_2$, $2Mg(F)(OH)$...Monosymmetric.
Humite, $Mg_5(SiO_4)_3$, $2Mg(F)(OH)$.....Orthorhombic.
Clinohumite, $Mg_7(SiO_4)_4$, $2Mg(F)(OH)$ ..Monosymmetric.
Prolectite, $MgSiO_4$, $2Mg(F)(OH)$ .....Monosymmetric.
Forsterite, Mg_2SiO_4 .....Orthorhombic.

The crystallographic data for, and the equivalence parameters of, these minerals are given in the following table:—

	W	a : b : c	x : y : z	z/W
Chondrodite	38	1·08630 : 1 : 3·14472	2·4249 : 2·2323 : 7·0199	0·18473
Humite	54	1·08021 : 1 : 4·40334	2·4278 : 2·2475 : 9·8965	0·18327
Clinohumite	70	1·08028 : 1 : 5·65883	2·4349 : 2·2540 : 12·7547	0·18221
Prolectite ...	22			
Observed..		1·0803 : 1 : 1·8862	2·3877 : 2·2102 : 4·1689	
Calculated		1·0822 : 1 : 1·8500	2·4292 : 2·2446 : 4·1526	
Forsterite	16			
Observed..		0·9296 : 1 : 1·1714	2·4492 : 2·2769 : 2·8691	
Calculated		0·9240 : 1 : 1·1804	2·4292 : 2·2446 : 2·8674	

It is clear that in passing from chondrodite to humite by addition of the increment Mg_2SiO_4, the latter is introduced into the assemblage as a layer parallel to the axial directions *a* and *b*, and perpendicular to the axis *c*, and that this process is repeated in passing from humite to clinohumite. The dimensions of this increment layer agree closely with those of the mineral forsterite, and a similar close agreement is found between the calculated and observed dimensions of the layer which may be regarded as the foundation of the series and has the composition of prolectite.

The method of treatment here adopted is applicable to double salts and to substances containing solvent of crystallisation in general, and shows that such molecular complexes are to be regarded as close-packed assemblages of the two or more component molecular complexes.

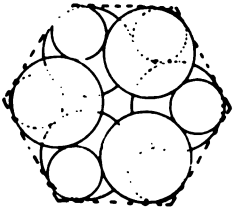

Fig. 1.

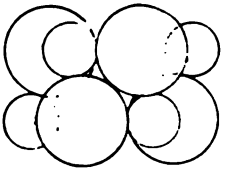

Fig. 2.

The problem involved in determining the configuration of the benzene molecule becomes practically determinate when the above methods are applied to the crystalline form and chemical properties of the hydrocarbon. The configuration of benzene which is thus arrived at is depicted in *Figs.* 1 and 2, which represent the plan and elevation respectively of the molecule. The dimensions of the close-packed homogeneous assemblage built up of units such as these are in harmony with the equivalence parameters deduced from the crystalline hydrocarbon and its per-halogen derivatives, namely :—

C_6H_6, $x : y : z = 3{\cdot}101 : 3{\cdot}480 : 2{\cdot}780$; $\beta = 90°$.
C_6Cl_6, " $= 3{\cdot}0169 : 3{\cdot}5894 : 2{\cdot}7714$; $\beta = 87° 50'$.
C_6Br_6, " $= 3{\cdot}0181 : 3{\cdot}6097 : 2{\cdot}7587$; $\beta = 87° 18'$.

In like manner configurations are assigned to the molecules of naphthalene, anthracene, triphenylamine, the di-hydroxybenzenes, and a number of triphenylmethane derivatives (see *Trans. Chem. Soc.*, 1906, 1675).

Just as the ordinary aspect of the valency law is exactly analogous to one geometrical property of close-packed assemblages of elastic spheres, so also is multivalency precisely analogous to another geometrical property of such assemblages. It has thus not been found necessary to assign different volumes to the spheres of influence of ter- and quinque-valent nitrogen, the fundamental valency of three determining the volume of the sphere of influence of the element.

The paper was illustrated by a number of models devised by the writers.

General Meeting, October 30th, 1906.

Mr. CHARLES BAILEY, M.Sc., F.L.S., in the Chair.

The PRESIDENT moved on behalf of the Council, and Mr. R. L. TAYLOR seconded the following resolution:—

"That in future the time of commencement of the Evening Meetings of the Society be changed from Half-past Six to Six o'clock."

It was carried unanimously.

Mr. CHARLES RENOLD, Engineer, Graduate of Cornell University, Ithaca, *Prestnall Hey, Heaton Mersey;* Miss IDA SMEDLEY, D.Sc., Assistant Lecturer in Chemistry in the University of Manchester; Mr. H. F. COWARD, M.Sc., Assistant Lecturer in Chemistry in the University of Manchester; Mr. E. C. EDGAR, D.Sc., Assistant Lecturer and Demonstrator in Chemistry in the University of Manchester; and Miss GRACE WIGGLESWORTH, M.Sc., *Sparth Mount, Heaton Norris*, were elected ordinary members of the Society.

Ordinary Meeting, October 30th, 1906.

Mr. FRANCIS NICHOLSON, F.Z.S., in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Dr. W. E. HOYLE, F.R.S.E., communicated the following papers by Mr. S. A. NEAVE, M.A., B.Sc., Naturalist to the North-east Rhodesia Geodetic Survey :—

"A Journey to North-east Rhodesia during 1904 and 1905," and **"On a Collection of Birds from North-east Rhodesia."**

A number of specimens of the skins of birds from the Manchester Museum were exhibited.

General Meeting, November 13th, 1906.

Mr. CHARLES BAILEY, M.Sc., F.L.S., in the Chair.

Mr. KENNETH FISHER, B.A. Oxon., Ph.D. Jena, Research Student in the University of Manchester, *The Lilacs, Timperley*, and Mr. DAVID M. S. WATSON, of the University of Manchester, *466, Moss Lane East, Manchester*, were elected ordinary members of the Society.

Ordinary Meeting, November 13th, 1906.

Mr. CHARLES BAILEY, M.Sc., F.L.S., in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Mr. R. L. TAYLOR drew attention to the remarkable luminosity produced by the rubbing or knocking together of various forms of silica. A correspondent in a local paper pointed this

out some little time ago, as a property peculiar to the white pebbles found on the coast at Whitby. All quartz pebbles show it remarkably well, and practically all the forms of silica which have been tried—including agate, chalcedony, rock crystal, opal, flint, &c. Smooth surfaces are not so effective as slightly roughened ones. When the substance used is translucent, it is quite lighted up at each stroke. Mr. Joseph Burton finds that quartz which has been fused is very effective. It is somewhat vesicular, and of lower specific gravity than ordinary rock crystal, and rubs away more easily. There is no doubt that the luminosity is connected in some way with the breaking away of small particles, mostly in the form of dust. Mr. Burton also find-that whereas ordinary felspar only shows this property in a very small degree, the same substance previously heated almost to fusion shows it almost as well as quartz. Common glass does not show it, but a specimen of glass "frit," rich in lead, and very hard does to a slight extent.

This curious luminosity may be partly due to the hardness of the material, but that it is not entirely so is shown by the fact that whereas a slight luminosity is shown when a piece of corundum or a piece of native emery is rubbed against a piece of silica, there is none whatever when two pieces of corundum or two pieces of native emery are knocked together.

There is a curious smell produced by the impact of any of these bodies which become luminous, a smell which has been compared to that of ozone. Mr. T. L. Phipson, in a book on Phosphorescence, published in 1870, says that he has shown that, in the case of quartz, ozone is produced.

But Mr. Taylor has not been able to verify that observation. Mr. F. Jones and Mr. Burton also made careful tests for ozone, and both failed to obtain any evidence of its presence.

Miss M. McNicol, B.Sc., read a paper entitled "**The Proembryo and Bulbils of** *Lamprothamnus alopecuroides* (Braun)." This plant, which occurs in various countries of Europe and also in Africa, is characterised by the possession of

unicellular bulbils or tubercles, formed by the transformation of rhizoids. Sometimes a sequence of two or even three tubercles may be seen. The tubercles, which are filled with starch, provide a food supply for the growth of new shoots: the nuclei of these tubercles are fragmented. Proembryos are formed in large numbers from the rhizoid nodes, but more especially from those nodes which bear tubercles. The cells forming the apex of the proembryo (Vorkeimspitze) become large and conspicuous; in them, fragmented nuclei of various shapes can be observed. Sometimes in addition to the rhizoid node of the proembryo, formed as in *Chara* by the cutting off of peripheral cells, there occurs below this node an interposed node from which spring rhizoids only. This interposed node differs from the rhizoid node proper in the manner of its formation, the lateral rhizoids being formed in a tuft on one side of the proembryo. Transitions from a true rhizoid formation to a proembryo also occur.

In the discussion which followed, Mr. CHARLES BAILEY gave an account of his collecting, in 1881, a large number of luxuriant examples of this species, in one of three salterns filled with brackish water, and situate near the site of Newtown, an extinct town in the Isle of Wight, near Yarmouth, represented in Parliament by two members from the days of Elizabeth down to 1832. In the saltern in question some of the plants were found two feet or more in height, and dried examples were exhibited to the members present. The same specimens are referred to in the *Proceedings* of the Society for the Session 1881-82, vol. 21, page 74. A living example of the plant was sent to Kew Gardens at the time, but it was promptly purloined. In later years the plant had been unsuccessfully sought for in the Newtown salterns, and when he visited the same spot in the year 1888 he found that it had completely disappeared through the conversion of the old salterns into an oyster park, its habitat being completely destroyed by the admission of sea-water. In more recent years it had been found growing at Poole, in Dorset, so that the species is not quite lost to the country.

General Meeting, November 27th, 1906.

Professor A. SCHUSTER, Sc.D., Ph.D, F.R.S., in the Chair.

Mr. NORMAN SMITH, D.Sc., Assistant Lecturer in Chemistry in the Manchester University, and Mr. THOMAS ALFRED COWARD, F.Z.S., *Brentwood, Bowdon*, were elected ordinary members of the Society.

Ordinary Meeting, November 27th, 1906.

Professor A. SCHUSTER, Sc.D., Ph.D., F.R.S., in the Chair.

The thanks of the members were voted to the donors of the books upon the table. The following were among the recent donations to the Society's Library:—"*De Uitvinding der Verrekijkers*," door C. de Waard Jr. (8vo., 's-Gravenhage, 1906), presented by the Zeeuwsch Genootschap der Wetenschappen; "*Le Opere di Galileo Galilei*," ed. naz., vols. 17, 18 (4to., Firenze, 1906), presented by the R. Ministero della Istruzione Pubblica; "*A Catalogue of the Aburi Gardens*," by A. E. Evans (8vo, London, 1906), presented by the Liverpool University Institute of Commercial Research in the Tropics; "*Geschiedenis der systematische Mineralogie*," door E. H. M. Beekman (8vo., Den Haag, [1906]), presented by the Technische Hoogeschool te Delft; "*Reduction of Greenwich Meteorological Observations*," pt. 4 (4to., Edinburgh, 1906), "*Catalogue of Stars for the Equinox 1900·0 from Observations made at the Royal Observatory, Cape of Good Hope, 1900-1904*" (4to., Edinburgh, 1906), and "*Catalogue of 8.560 Astrographic Standard Stars... for the Equinox 1900* (4to., London, 1906), presented by the Royal Observatory, Greenwich.

HENRY WILDE, D.Sc., D.C.L., F.R.S., read a paper entitled "**On some Points of Chemical Philosophy involved in the Discovery of Radium and the Properties of its Combinations.**"

Mr. J. COSMO MELVILL, M.A., F.L.S., read a paper written in conjunction with Mr. R. Standen, entitled "**On a Collection**

of Land and Freshwater Mollusca collected by Mr. S. A. Neave in North-east Rhodesia."

Specimens of the shells of a number of the species described were exhibited.

The communication standing in the name of Dr. F. W. GAMBLE was postponed to the next meeting on December 11th.

Ordinary Meeting, December 11th, 1906.

Mr. FRANCIS NICHOLSON, F.Z.S., in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Dr. F. W. GAMBLE presented a short communication on the discovery by Bütschli of strontium sulphate as the basis of the skeleton in certain Radiolaria (Acantharia). Up to the present time the nature of the Acantharian skeleton was a disputed subject. Johannes Müller, who first described it, regarded its basis as siliceous. Haeckel subsequently carried out a series of tests that seemed to establish an organic horny substance as the chief component of the skeleton, and to this he gave the name *Acanthin*. Since this analysis has been universally accepted, it seems desirable to record Bütschli's results, which are both contradictory to Haeckel's, and apparently conclusive from the convergent and confirmatory outcome of the different tests employed by him. Working with material brought back by the German Antarctic expedition, and also upon Mediterranean Acantharia, Bütschli has shewn that strontium sulphate is the material of which the complex rods and spicules of these Radiolaria are composed. This is the first time that strontium has been described in animal tissues, and coincides with the recent discovery of barium sulphate in certain other deep-sea Protozoa (Xenyophophoridæ).

Professor F. E. WEISS, D.Sc., F.L.S., read a paper entitled **"The Parichnos in the Lepidodendraceæ."**

Miss KATHARINE H. COWARD, B.Sc., read a paper (communicated by Professor F. E. WEISS, D.Sc., F.L.S.) entitled,

"**On the Structure of Syringodendron, the Bark of** *Sigillaria.*"

General Meeting, January 15th, 1907.

The President, Sir WILLIAM H. BAILEY, in the Chair.

Mr. H. C. H. CARPENTER, M.A., Ph.D., Professor of Metallurgy in the University of Manchester, was elected an ordinary member of the Society.

Ordinary Meeting, January 15th, 1907.

The President, Sir WILLIAM H. BAILEY, in the Chair.

The thanks of the members were voted to the donors of the books upon the table. The following were among the recent accessions to the Society's Library:—"*Special Reports (of the Department of Commerce and Labour, Washington). The Blind and the Deaf, 1900,*" (4to., Washington, 1906) presented by the Bureau of the Census of Washington; "*Report on the Boundary Survey between British Bechuanaland and German S. W. Africa,*" executed by Lieut.-Col. Laffan...and others (fol., Berlin, 1906) presented by the Cape of Good Hope Observatory; "*Astrographic Catalogue 1900·0. Oxford Section Dec. + 24° to + 32°...*" [prepared] under the direction of H. H. Turner...vol. 1, (4to., Edinburgh, 1906) presented by the Oxford University Observatory; "*Bibliographia Geologica,*" par M. Mourlon ... Sér. A, tome ix. (8vo., Bruxelles, 1906) purchased; "*Gutsherrlich-bäuerliche Verhältnisse in der Ober-Lausitz*"...von F. Moeschler (8vo., Görlitz, 1906), "*Codex Diplomaticus Lusatiae Superioris iii....*" von Dr. R. Jecht, Hft. 2 (8vo. Görlitz, 1906) presented by the Oberlausitzische Gesellschaft der Wissenschaften.

Mr. C. E. STROMEYER, M.Inst.C.E., read a paper entitled, "**The Grouping of the Chemical Elements.**"

The reading of Mr. A. D. DARBISHIRE's paper entitled, "**Some Tables for Explaining the Nature of Statistical Correlation**" was postponed until the next Meeting.

Ordinary Meeting, January 29th, 1907.

Mr. FRANCIS NICHOLSON, F.Z.S., in the chair.

The thanks of the members were voted to the donors of the books upon the table.

Mr. C. L. BARNES, M.A., called attention to passages in Dante which seem in some degree to foreshadow the lately-discovered "speaking arc," exhibited by Mr. W. Duddell in his concluding lecture to juveniles at the Royal Institution. In Canto XXVI of the "Inferno," Dante and Virgil have reached the eighth circle of the abyss, and see before them a valley dotted with a multitude of flames, which the poet compares to the fireflies so familiar on warm evenings in Italy. One of these flames is double horned, and conceals the shades of Ulysses and Diomede. Virgil commands it to approach, whereupon

> Of the old flame forthwith the greater horn
> Began to roll, murmuring, as a fire
> That labours with the wind; thus to and fro
> Wagging the top, as a tongue uttering sounds,
> Threw out its voice and spake.

From another flame, bidden in like manner to draw near, sounds issue forth which are compared to the groans of the inventor and first victim of the bull of Phalaris. These sounds,

> While no way they found,
> Nor avenue immediate through the flame,
> Into its language turned the dismal words.
> But soon as they had won their passage forth
> Up from the point, which vibrating obeyed
> Their motion at the tongue . . . .

they become articulate, and in a speech of some length Count Guido da Montefeltro relates the story of his misdeeds.

Mr. D. M. S. WATSON read a paper entitled, "**On a Confusion of two species of** *Lepidodendron* (*L. Harcourtii*, **Witham, and** *L. Hickii*, **sp. nov.), under** *L. Harcourtii*, **Witham, in Williamson's XIXth Memoir, with a description of** *L. Hickii*, **sp. nov.**"

Dr. W. E. HOYLE, F.R.S.E., communicated a paper by Mr. R. C. WROUGHTON, of the British Museum (Natural History), entitled "**On a Collection of Mammals made by Mr. S. A. Neave in Rhodesia, North of the Zambesi, with Field Notes by the Collector.**"

Ordinary Meeting, February 12th, 1907.

Mr. FRANCIS NICHOLSON, F.Z.S., in the Chair.

The thanks of the members were voted to the donors of the books upon the table. The following were among the recent accessions to the Society's Library :—"*Licensing and Temperance in Sweden, Norway, and Denmark*," by E. A. Pratt (8vo., London, 1907), presented by the author; "*France in North Africa, 1906*," by T. W. Balch (1a. 8vo., Philadelphia, 1906), presented by the author; "*The Record of the Celebration of the 200th Anniversary of the Birth of Benjamin Franklin...April 17-21, 1906*" (4to, Philadelphia, 1906), presented by the American Philosophical Society; "*The British Tunicata...*" By J. Alder and A. Hancock...vol. 2 (8vo., London, 1907), purchased from the Ray Society.

Mr. C. S. ALLOTT, M.Inst.C.E., and Mr. D. L. CHAPMAN, M.A., were nominated auditors of the Society's accounts for the Session 1906-07.

Dr. W. E. HOYLE, F.R.S.E., exhibited a coloured sketch of a specimen of *Beryx splendens*, recently presented to the Manchester Museum by Mr. W. Vernon. It is of interest as having been taken just on the boundary of the British Marine Area, as defined by the Rev. A. M. Norman, F.R.S. It was taken by the trawler "Evaline," in lat. 49° 10′ N., long. 11 W., at a depth of from 170 to 200 fathoms The species seems to have been first recorded from Madeira, and is known from the coasts of Spain and Portugal.

Mr. JOHN R. RAGDALE exhibited and described a number of

arrow heads and obsidian chippings found by him in an Indian encampment, June, 1906, on Gold Hill, Cascade Range, near Eugene, Oregon, U.S.A., also specimens from the obsidian cliff in the Yellowstone Park, Montana.

Some modern and prehistoric pottery, a cinerary urn, and stone axe-head from the old Aztec ruins and the Indian pueblo of Acoma, New Mexico, and many beautiful specimens of petrified wood were also shewn, these latter from the petrified forest of Adamana Apache, County Arizona, where there are thousands of acres in places thickly strewn with trunks and segments of trees, the ground being covered with chip-like fragments of agatized wood.

Lantern views of the forests and the natural log bridge, 200 feet long, which spans a chasm 60 feet wide, and other interesting views of Indians and scenery in New Mexico, Arizona, and other parts of the States, taken during a visit made in April and May, 1906, were thrown on the screen.

Mr. J. E. PETAVEL, M.Sc., gave a short description of various forms of apparatus which he has designed for experimental work at very high gaseous pressures, and mostly in use at the Physical Laboratories of the Manchester University.

The details of construction were illustrated by numerous lantern slides.

Special attention was paid to an improved hydraulic pump, capable of adaptation to many uses, and attaining a working pressure of 2,000 atmospheres.

A method which has proved satisfactory for compressing pure gases by forcing glycerine into a cylinder containing the gas was also fully explained.

The pressures dealt with ranged from 3,000 to 30,000 lbs. per square inch.

Mr. C. G. HEWITT, B.Sc., read a paper by Mr. A. D. DARBISHIRE, M.A., entitled "**Some Tables for explaining the Nature of Statistical Correlation.**"

Special Meeting, February 18th, 1907.

The President, Sir WILLIAM H. BAILEY, in the Chair.

The Wilde Lecture, on "**The Structure of Metals,**" was delivered by J. A. EWING, Esq., LL.D., F.R.S., M.Inst.C.E., Director of Naval Education to the Admiralty.

Ordinary Meeting, February 26th, 1907.

Professor H. B. DIXON, M.A., F.R.S., in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Professor H. B. DIXON, made reference to the recent death of an Honorary Member, Professor Henri Moissan, whose fame, he said, rested on his being the first to isolate fluorine and to prepare artificial diamonds.

Dr. R. S. HUTTON added that Moissan had more than once expressed his appreciation of the honour conferred upon him by the Society in electing him an honorary member at a time when his work had not obtained general recognition.

Mr. THOMAS KAY, of Stockport, read the following communication :—

I have to shew you a piece of new red sandstone of this district picked up above the clay in the camp site of Mancunium which is somewhat remarkable, for it was picked up out of the black soil and rubbish dug out of the place where the Roman Vase was found—and it arrested my attention by its distinct character from all the other stones which were of a gravelly nature in the heap.

Only after washing and scrubbing it was its true nature discovered.

At first I thought it was part of a whetstone, a sharpener for swords and polisher of metal, as I find that the fine particles form an excellent scouring medium.

It looks as if it was only the half of a hone but if so I have not been able to find the other piece.

It is remarkable as being a piece of new red sandstone with Encrinite stems on and in it. It seems to be from the very bottom of the sea with a layer of lime forming, and particles of Encrinites, washed into the sand from which they probably grew, but there are no traces of roots or lily heads of the crinoidæ.

It is rather curious, too, that the line of stratification of the rock is at right angles to the lime base, but this may have been a sun-crack made up by a cementing material.

There are evidences of the clay outside the Western rampart having been used for making bricks by the broken material lying where the old kilns were placed.

There is also evidence of red sand having been brought into the camp, probably to dust the soft bricks when placing them to dry, and although this specimen of solidified sand containing the Encrinite stems was some distance away and amidst the débris excavated from beside the Roman Vase, it may be that this piece of stone was thrown out and found its place above or about the said vase at the time of brick making. In this case there can be nothing particular about its association with the Romans, except its peculiarity in being the only specimen of the kind I have seen or heard of, and the fact that there is no specimen in the Museum of the Victoria University of a like character, *i.e.*, of Encrinites in the new red sandstone.

I suppose fossils in the new red sandstone of this district are extremely rare except on the East side at Heaton Norris where some bivalve casts have been found, specimens of which are to be seen in the Museum.

Only the tracks of Batrachians are common on the Western shores of the Red Sandstone about Lymm, but no fossils unless the pseudo-morphs of salt crystals can be so termed which have been found in the Ship Canal excavations at Warburton.

From the white calcareous deposit on the stone it would seem that this was taken from the extreme edge of the lime basin in which it grew and that the drift of the new red sand

was blown into the lime basin, probably at Ardwick. The particles of sand constituting the stone are extremely fine and are aggregated by lime infiltration and the shapes of Encrinites have been filled in with sparkling crystals.

In ancient days Britain was celebrated for its tin and it is thought that when British tin was first alloyed with the copper of Cyprus it marked the commencement of the era of what is known in History as the Bronze Age. We also know that the Romans obtained pearls from the Conway Estuary, and there can be little doubt that in their following they had geologists to seek out the mineral wealth of the countries which they conquered.

It is interesting, therefore, to imagine some ancient mineralogist picking up this curious stone, if only to see of what these glistening crystals were composed, and leaving it beside the vase in Roman Mancunium of which latter there can be little reasonable doubt that it appertains to the Roman times in Britain.

Mr. CHARLES OLDHAM exhibited a melanic example of the Brown rat (*Mus decumanus*, Pallas), from County Wexford. The black form of our common Brown Rat was, in 1837, referred to a distinct species—*M. hibernicus*—by Thompson, the Irish naturalist, who believed it to be allied to the Black Rat, *M. rattus*, L. This opinion was not shared by Blasius and other mammalogists, but much uncertainty obtained as to the true affinities of the animal until the publication of a paper by Messrs. Eagle Clarke and Barrett Hamilton in the *Zoologist* for 1891. The authors showed conclusively that the so-called Irish Rat was merely a melanic variety of *M. decumanus*. It is subject to considerable variation; in many examples there is a white spot on the chest, and the fur of the belly is sometimes rusty brown in the median line. In the specimen exhibited there were many silvery white hairs in the coal black fur of the upper parts. The animal has a wide distribution in Ireland, is found locally in the outer Hebrides and in Norfolk and other

East Anglian counties. It has also been recorded from Lundy Island and Devonshire.

Mr H. J. Woodall described a curious case of the freezing of water in a bottle during the recent cold weather.

Mr. Henry Sidebottom read a paper entitled, "**Report on the Recent Foraminifera from the coast of the Island of Delos (Grecian Archipelago) Part IV.**" Drawings of some of the more interesting species were exhibited, and mounted specimens were shown under the microscope.

Miss Madeline Carson, B.Sc., read a paper communicated by Professor F. E. Weiss, D.Sc., F.L.S., entitled, "**The Leaves of *Passerina***."

The Passerinæ belong to the natural order Thymeleaceæ. These plants inhabit the warm dry regions of Egypt, S. Africa, and the Mediterranean. They are common on the sand hills near the coast, and always live under conditions in which there is a difficulty of obtaining water. In order to combat against this, they are specially modified. The leaf surface is reduced, often the leaves are imbricating. They are provided with a very thick cuticle, have the edges rolled, and the stomates are found only on the inner surface. They are further protected by a covering of hairs.

The chief object of the study of these leaves was to discover whether the epidermal cells contained mucilage or not. Van Laeghem (93) after an exhaustive study classified these plants according to their anatomical structure. He bases his classification partly upon the fact that some genera contain mucilaginous cells in the epidermis, while others do not. Among the latter he includes all species of *Passerina*. Karl Supprian (94) in his "Beitrage zur Kenntniss den Thymeliaceæ und Penæaceæ" finds mucilage in the epidermal cells of *Passerina ericoides*, but in no other species.

In *Passerina filiformis* and in *Passerina hirsuta*, I found that in many of the epidermal cells a portion was cut off from the rest by a cellulose wall. The upper portion contained tannin

and probably mucilaginous sap, while the lower portion consisted of hard stratified mucilage.

In the other species examined *Passerina ericoides* and *Passerina rigida*, I found no trace of separation of the epidermal cells into a striated and non-striated ortion. The whole epidermal cell stained with mucilage stains and tannin stains. Since mucilage and tannin both act in the same way towards methylene blue, and since it is impossible to separate tannin and mucilage, the evidence for the presence of mucilage in these species is not perfectly conclusive. As, however, mucilage is without doubt found in some Passerinæ, its absence is not characteristic of the group, and therefore its presence or absence can no longer be used as a basis for classification of the Thymelæaceæ.

Ordinary Meeting, March 12th, 1907.

Professor W. BOYD DAWKINS, D.Sc., F.R.S., in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Mr. C. L. BARNES, M.A., was nominated auditor of the Society's accounts for the Session 1906-07 to fill the vacancy caused by the death of Mr. C. S. ALLOTT.

Mr. CHARLES BAILEY, M.Sc., F.L.S., exhibited a small slab of dark-coloured oak timber, which had formed a portion of the lower end of a thick staff, employed in a metal works for stirring up molten tin to ensure the better admixture of the metal. The tin had infiltrated into the wood, but while it had filled up the pores, or vessels of the timber only to a limited extent, it had become concentrated in the medullary rays, so that in transverse section these rays were transformed into thick lines of solid white metal. Mr. Bailey was unable to account for the selective affinity of the metal for the densest portion of the timber: there was no visible trace of the wood cells of the rays, as they had been completely absorbed by the tin. The dark colour of the wood

would be due to carbonisation produced by the fluid metal, but still more to the oil employed in the melting and mixing process.

Dr. F. W. GAMBLE read a paper written in conjunction with Dr. F. KEEBLE, and entitled "**The Occurrence and Significance of Symbiotic Corpuscles in the Lower Animals.**"

The paper described the occurrence of symbiotic coloured corpuscles in the bodies of lower animals. It dealt in detail with a single case, that of the simple Turbellarian worm *Convoluta roscoffensis*, and discussed the evidence for describing the green cells of the animals as an "infection" by a flagellated vegetal organism.

The nature and life-history of this organism were described, and the significance of the association of this organism and of the animal *Convoluta* was discussed.

At this point the Chair was taken by Dr. W. E. HOYLE, F.R.S.E.

Mr. FRANCIS NICHOLSON, F.Z.S., then exhibited some bones of the Great Auk from Funk Island, Newfoundland, and read the following account of them :—

The bones exhibited on the table are those of the now probably extinct species of bird, the Great Auk, or Gare-fowl, *Alca impennis* of Linnaeus. They were presented to the late Sir Francis H. Evans, Bart., about twenty years ago, when he was on a visit to Newfoundland, by a man who had obtained them from Funk Island. This island is a flat granite rock, a little over a mile in length and a quarter of a mile in breadth, which lies about 32 miles from the most eastern headlands of Newfoundland. Its southern, south-eastern, and south-western sides are bounded by cliffs from 30 to 50 feet in height, whilst the remaining northern and north-eastern portions shelve gradually towards the sea. At no point is there anything like a beach to divide the solid rock from the water.

There are seven bones in this collection consisting of—1 base of skull; 1 Clavicle; 1 Sacral Vertebræ; 2 right Humeri; 2

right Tibiæ. From the foregoing it is evident we have the remains of more than one bird. Unfortunately I am not in a position to give any further particulars of these bones as Sir Francis Evans sent them to me only a few days before he died in January last, and they were unaccompanied by a letter, though he had actually started to write one, as it was on his desk after his death.

I do not propose to give an extended description or detailed account of the life-history of the Great Auk, on this occasion, as it is hardly necessary, seeing that it has been very ably and fully done elsewhere by numerous writers. A few remarks, however, about this most interesting bird may be welcome to those amongst us who have not made a study of Ornithology.

In size the Gare-fowl was hardly less than a tame goose, and in appearance it much resembled its smaller and surviving relative the Razor-bill, *Alca torda*, but the glossy black of its head was varied by a large patch of white occupying nearly all the space between the eye and the bill, in place of the Razor-bill's thin white line. The most striking characteristic of the Gare-fowl, however, was the comparatively abortive condition of its wings, the distal portions of which, though the bird was just about twice the linear dimensions of the Razor-bill, were almost exactly of the same size as in that species—proving, if more direct evidence were wanting, its inability to fly. The most prevalent misconception concerning the Great Auk is the notion it was a bird possessing a very high northern range, and consequently was to be looked for by Arctic explorers. How this error arose would take long to tell, but the fact remains that there is little or no evidence that it has occurred within the Arctic Circle. Its principal haunts were certain islands in the neighbourhood of Newfoundland, others near the east coast of Greenland, and some skerries off the south-west of Iceland, whence the last recorded specimens "in the flesh" were obtained in the year 1844.

These bones I have had the pleasure of presenting to the Manchester Museum at the Victoria University.

Ordinary Meeting, March 26th, 1907.

Mr. FRANCIS NICHOLSON, F.Z.S., in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Mr. T. THORP, F.R.A.S., made a short communication on an apparent case of gaseous absorption caused by the action of a few milligrams of radium bromide on the sides of a glass tube containing the radium.

At first there was an expansion but later on, as the glass turned purple, a contraction took place to less than the original volume.

Further investigations are being made, the results of which will be communicated to the Society.

Dr. W. E. HOYLE, F.R.S.E., communicated a paper by Mr. G. A. BOULENGER, F.R.S., of the British Museum, entitled "**On a Collection of Fishes, Batrachians, and Reptiles made by Mr. S. A. Neave in Rhodesia, North of the Zambesi, with Field Notes by the Collector.**"

An account was then given of the following paper:

"**A New Class of Organo-Metallic Compounds. Trimethylplatinimethyl Hydroxide and its Salts.**" By WILLIAM JACKSON POPE, F.R.S., and STANLEY JOHN PEACHEY.

No alkyl compounds of metals belonging to groups 1 and 8 of the periodic table have hitherto been described. The authors find that the chlorides, or in some cases, the oxides, of iron, cobalt, nickel, ruthenium, rhodium. palladium, osmium, iridium and platinum, belonging to group 8, and of gold, belonging to group 1, react vigorously with magnesium methyl iodide.

Trimethylplatinimethyl iodide, $(CH_3)_3Pt.I$, is formed by the action of platinic chloride dissolved in ether upon magnesium methyl iodide in ethereal benzene solution; after treating with water and extracting with benzene the benzene solution yields

the new compound on evaporation. It crystallises in straw-yellow plates, is not volatile, and decomposes on heating with slight explosion; it is very stable towards reagents, and is not attacked in the cold by strong caustic alkalies, alkali sulphides, or by nitric, hydrochloric or sulphuric acids. It is not further acted on by magnesium methyl iodide. On boiling for several hours with silver hydroxide in a moist mixture of benzene and acetone, it is converted into *trimethylplatinimethyl hydroxide*, $(CH_3)_3Pt.OH$. This substance is insoluble in water, gives no alkaline reaction with litmus, and crystallises in colourless rhombic dodecahedra belonging to the cubic system.

Trimethylplatinimethyl nitrate, $(CH_3)_3Pt.NO_3$, obtained by dissolving the hydroxide in nitric acid, crystallises in colourless plates and is freely soluble in water. On adding an alkali chloride to its aqueous solution, *trimethylplatinimethyl chloride*, $(CH_3)_3Pt.Cl$, is precipitated. This salt crystallises from chloroform in colourless rhombic dodecahedra belonging to the cubic system. In a similar manner a number of other salts have been prepared, including the *bromide* and the *cyanide*; the latter is hydrolysed on heating with caustic potash with evolution of ammonia.

Ordinary Meeting, April 9th, 1907.

Mr. ARTHUR MCDOUGALL, B.Sc., in the Chair.

The thanks of the members were voted to the donors of the books upon the table. The following were among the recent accessions to the Society's Library:—"*Reports of the Mediterranean Fever Commission, Part 5*" (8vo., London, 1907), presented by the Royal Society of London; "*A Chemical Conception of the Ether*," by D. Mendeléeff (8vo., London, 1904), presented by Dr. Henry Wilde, F.R.S.; "*Preliminary Report on the Rossland, B.C., Mining District*," by R. W. Brock (8vo., Ottawa, 1906),

"*Report on the Chibougamau Mining Region in the northern part of the Province of Quebec*," by A. P. Low (8vo., Ottawa, 1906), "*Section of Mines: Annual Report for 1904*" (8vo., Ottawa, 1906), presented by the Geological Survey of Canada; "*Œuvres complètes*," de J. C. Galissard de Marignac, 2 Tomes. (4to., Genève, etc., [1907]), presented by the Société de Physique et d'Histoire Naturelle de Genève; "*Ballistic Experiments from 1864-1880*," by F. Bashforth (8vo., Cambridge, 1907), presented by the author; "*Astronomische Beobachtungen an der k. k. Sternwarte zu Prag in den Jahren, 1900-1904...*," von Dr. L. Weinek (4to., Prag, 1907), presented by the K. k. Sternwarte zu Prag.; "*An Investigation of Evolution in Chrysomelid Beetles of the genus Leptinotarsa*," by W. L. Tower (la. 8vo., Washington, 1906), presented by the Carnegie Institution of Washington; "*Dal Canzoniere di Béranger*," traduzione di D. Mancini (4to., Terni, 1907), presented by Prof. D. Mancini; "*Maize, Cocoa and Rubber: Hints on their Production in W. Africa*," by Viscount Mountmorres (8vo., Liverpool, 1907), presented by the Liverpool University Institute of Commercial Research in the Tropics; and "*Over de Exhaust-werking bij Locomotieven*," [by] F. C. Huygen (4to., Rotterdam, [1907]), presented by the Technische Hoogeschool te Delft.

Mr. CHARLES BAILEY, M.Sc., F.L.S., read a paper, entitled "**Further Notes on the Adventitious Flora of the Sandhills of St. Anne's-on-the-Sea.**"

Annual General Meeting, April 23rd, 1907.

The President, Sir WILLIAM H. BAILEY, in the Chair.

The Annual Report of the Council and the Statement of Accounts were presented, and it was resolved:—"That the Annual Report, together with the Statement of Accounts, be adopted, and that they be printed in the Society's *Proceedings*."

Mr. C. E. STROMEYER and Mr. H. B. KNOWLES were appointed Scrutineers of the balloting papers.

The following members were elected officers of the Society and members of the Council for the ensuing year:—

President: H. B. DIXON, M.A., F.R.S.

Vice-Presidents: Sir WILLIAM H. BAILEY, M.I.Mech.E.; HORACE LAMB, LL.D., D.Sc., F.R.S.; FRANCIS JONES, M.Sc., F.R.S.E.; W. E. HOYLE, D.Sc., F.R.S.E.

Secretaries: F. W. GAMBLE, D.Sc.; R. L. TAYLOR, F.C.S., F.I.C.

Treasurer: ARTHUR MCDOUGALL, B.Sc.

Librarian: R. S. HUTTON, D.Sc.

Other Members of the Council: FRANCIS NICHOLSON, F.Z.S.; CHARLES BAILEY, M.Sc., F.L.S.; THOMAS THORP, F.R.A.S.; CHARLES OLDHAM; ERNEST F. LANGE, F.C.S.; WILLIAM J. POPE, F.R.S., F.C.S.

Ordinary Meeting, April 23rd, 1907.

The President, Sir WILLIAM H. BAILEY, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Miss M. C. STOPES, D.Sc., Ph.D., made a communication as to the coal mine now working in Sutherlandshire, which is of mesozoic age and thus unlike the vast majority of coal seams in Europe, which are of palæozoic age. She reported that a number of genera of plants found in the beds associated with the deposits afford evidence that the Flora of Sutherland at that time closely corresponded with the Inferior Oolite Flora of the Yorkshire coast. The coal itself appears to have been deposited in an estuary and rapidly accumulated deposits with marine shells from its roof.

Mr. C. L. BARNES, M.A., read a paper, entitled "**Science and Poetry**," of which the following is an abstract:—

The paper was an attempt to enumerate the principal ancient and modern poems which have any claim to be called scientific. Paradoxical though it may seem, prose, considered in its literary aspect, is of later growth than poetry, the reason being that men learned to sing and to dance long before they learned to write. By the time the latter art had assumed a definite form the art of versification had already made considerable progress, the *leit-motif* being usually the praises of heroes and warriors, or philosophical musings, or the operations of Nature, then ascribed to the immediate action of deities. The Homeric poems are a classic example of this tendency, and of earlier date are the hymns to Osiris, Thammuz, or Astarte, found on Egyptian and Babylonian tablets. It is well known also that several portions of the Bible are written in metrical form.

The earliest extant poems of a scientific kind are the "Phænomena" and "Prognostica" of Aratus, written in Greek, which date from the 3rd century B.C., and are doubtless the source of the weather-lore in the "Bucolics" and "Georgics" of Virgil. To the following century belong the "Theriaca" and "Alexipharmaca" of Nicander, also in Greek; the former contains a list of remedies against the bites of snakes and other venomous animals; the latter is a compendium of antidotes to poisons in foods and drinks.

Roman literature, as might be expected, is more fertile in poems of the kind under consideration, and at the head of all stands the "De Rerum Natura" of Lucretius (1st century B.C.). In addition to many shrewd observations "on the nature of things," and intelligent gropings after truth, it preaches an entire disbelief in a future life together with a high moral code, a combination rare at any period of the world's history. The only works of Virgil which may be admitted into this category are the two already mentioned, but his contemporary Manilius is the reputed author of a poem in five books,

entitled "Astronomicon," which treats of astronomy and astrology, and is of high merit. A poem on Aetna, by Lucilius Junior, dates from the 1st century A.D., but must have been composed before the great eruption of Vesuvius in the year 79, as it contains no mention of that disaster. Avienus (4th century A.D.) translated the "Phænomena" of Aratus into Latin verse, and also a book of travel by Dionysius Periegetes, under the title of "Descriptio Orbis Terrarum." To him we also owe "Ora Maritima," a description of the Mediterranean and Black Seas. Another metrical translation of Dionysius, by Priscianus, dates from the 6th century.

After this a considerable interval follows, the next poem to claim mention being the "Physiologus" or "Bestiary" of Theobaldus, an Italian, written between 1022 and 1035. In accordance with the custom of the Middle Ages it deals far less with the real than the fancied habits of the creatures discussed, and is little, if at all, in advance of the works of Aristotle and Pliny. Myths and superstition are rampant throughout, almost every animal quality being identified with the good or the evil principle in nature, for the purpose of drawing a moral. The "De Gemmis" of Marbodus, an Englishman, who was Bishop of Rennes between 1096 and 1123, has attained some notoriety, the opening words "Evax rex Arabum" referring to an entirely mythical King of Arabia. Alexander Neckam (12th century) wrote "De Laudibus Divinæ Sapientiæ," a metrical version of his own "De Naturis Rerum," and to about the same period belong Philippe de Thaune's "Le Livre des Créatures," and the "Bestiaire Divin" of Guillaume, "le clerc de Normandie."

A rather surprising amount of alchemical lore is found in Chaucer's "Canon's Yeoman's Tale" (14th century), after which there is again a gap till we come to the age of Fletcher, Milton, and Cowley. Neither the former's "Purple Island," nor yet the "Plantarum Libri Duo," nor the "Ode to the Royal Society" of Cowley, is worth more than a passing mention, while the grandeur of "Paradise Lost" is extra-scientific, and therefore

outside the scope of the paper. The astronomy of the poem is founded on the Ptolemaic system, though the possible triumph of the latter is expressly admitted in Book VIII. The account of the Creation in Book VII. is taken direct from Biblical sources, an inevitable proceeding under the circumstances. In "Natura non pati senium" (Nature not subject to old age), Milton departs so far from the traditional custom of poets as to insist that the earth is not losing its vigour, and that the operations of Nature are conducted on the same scale as heretofore. Darwin's "Botanic Garden," or "The Loves of the Plants," contains an oft-quoted allusion to the then undeveloped powers of steam, but the general style of the poem is heavy, and its weakness soon provoked Canning to parody it in "The Loves of the Triangles." In more recent times (1844) the Rev. John Selby Watson, of Guernsey, published a poem on Geology in five books, which on the whole is a meritorious piece of work, and the list is completed by Mr. J. F. Rowbotham's "Human Epic" (1906), the most learned of modern efforts in this direction.

Reference was also made to the "Fugitive Poems" collected by Daubeny (1869), to Lord Neaves's "Songs and Verses," and lighter effusions by O. W. Holmes, Maxwell, Rankine, Bret Harte, and several anonymous writers.

Ordinary Meeting, May 7th, 1907.

The President, Professor H. B. DIXON, M.A., F.R.S., in the Chair.

The thanks of the members were voted to the donors of the books upon the table. The following were among the recent accessions to the Society's Library:—"*Anatomie de la tête du* Lasius niger." Par Ch. Janet (8vo., Limoges, 1905), presented by the author; "*Di alcune importanti questioni filosofiche.*" G. C. Paoli (8vo., Milano, 1907), presented by the author.

Professor F. E. WEISS, D.Sc., F.L.S., exhibited a series of photographs illustrating the vegetation of Corsica. Beginning with the plants found near the shore he showed how well protected they were against the drought to which they were exposed during the summer months. Dwarf shrubs of Helichrysum and tufts of leafless sea-lavender (*Statice articulata*) were most characteristic of this zone. A little further from the sea the slopes showed rather more abundant vegetation consisting largely of various species of Rock-Rose (*Cistus*) with handsome white flowers and fragrant foliage. Interspersed with these were clumps of Asphodel, while on the roots of the Rock-rose the bright coloured *Cytinus* was found as a parasitic plant. Above this region the slopes are covered by the macchia or maquis, a typical Mediterranean brushwood, consisting largely of shrubby arbutus and evergreen oaks interspersed with the tree-heath (*Erica arborea*). This plant-formation resembles very much the bush found on the slopes of Table Mountain and in other places in South Africa.

Above the macchia which clothes the foothills, and more inland are found large forests of Corsican pine and groves of beeches and other deciduous trees. The highest mountain slopes are studded with small spring shrubs, largely Leguminosæ while Alpine plants allied to those of the Swiss Alps are found on the rocky summits.

Mr. C. L. BARNES, M.A., concluded his paper on "Science and Poetry," by reading a selection of the poems he has collected from various sources. Among these were verses by Professor J. C. Maxwell, Professor Rankine, and Archbishop Whateley.

Mr. J. E. PETAVEL, M.Sc., F.R.S., read a paper entitled **"On the Compression of Gases by means of Hydraulic Apparatus."**

Annual Report of the Council, April, 1907.

The Society began the session with an ordinary membership of 151. During the present session 12 new members have joined the Society; 12 resignations have been received, and there has been one death, *viz.*: Mr. CHARLES SNEATH ALLOTT, M.Inst.C.E. This leaves on the roll 150 ordinary members. The Society has also lost, by death, 7 honorary members, *viz.*: Professor F. BEILSTEIN, Ph.D., of St. Petersburg; Professor M. P. E. BERTHELOT, For.Mem.R.S., Secrétaire perpétuel de l'Académie des Sciences, Paris; Professor LUDWIG BOLTZMANN, For.Mem.R.S., of Vienna; Sir MICHAEL FOSTER, K.C.B., Sec. R.S., of Cambridge; Professor D. MENDELÉEFF, Ph.D., For. Mem.R.S., of St. Petersburg; Professor HENRI MOISSAN, of Paris; and Professor H. MARSHALL WARD, D.Sc., F.R.S., of Cambridge. Memorial notices of these gentlemen appear at the end of this report.*

The Society commenced the session with a balance in hand of £426. 10s. 5d., from all sources, this amount being made up of the following balances:—

At the credit of General Fund	£69	18	10
„ „ Wilde Endowment Fund...	248	16	1
„ „ Joule Memorial Fund.....	72	11	4
„ „ Dalton Tomb Fund	35	4	2
	£426	10	5

The total balance in hand at the close of the session amounted to £214. 16s. 7d., and the amounts standing at the

* The memorial notice of Professor F. Beilstein, who died on October 18th, 1906, will appear in the next volume.

credit of the separate accounts, on the 31st March, 1907, are the following:—

At the credit of General Fund	£26	16	0
„ „ Wilde Endowment Fund...	71	12	9
„ „ Joule Memorial Fund	80	6	2
„ „ Dalton Tomb Fund	36	1	8
Balance 31st March, 1907.....	£214	16	7

The Wilde Endowment Fund, which is kept as a separate banking account shows a balance of £71. 12. 9d. in its favour, as against £248. 16s. 1d., at the beginning of the financial year, the receipts from the invested funds being the same as last year.

During the summer several improvements and alterations to the Society's house were carried out, including the provision of a ladies' lavatory on the upper floor. Dr. H. Wilde as a member of the Committee appointed to carry out these improvements has received the thanks of the Council for the time and attention he bestowed in devising and superintending them. The cost, amounting to £248. 1s. 9d., has been charged to the Wilde Endowment Fund.

The Librarian reports that during the session 654 volumes have been stamped, catalogued and pressmarked, 615 of these being serials, and 39 separate works. There have been written 249 catalogue cards, 192 for serials, and 57 for separate works. The total number of volumes catalogued to date is 29,776 for which 10,444 cards have been written.

Satisfactory use is made of the library for reference purposes, but the number of volumes consulted is not recorded. During the session, 176 volumes have been borrowed from the library, as compared with 160 in the previous session.

Some attention has continued to be paid to the completion of sets, 31 volumes or parts having been obtained, which partly

complete three sets. Of these, 8 parts were purchased, and the rest were presented by the society publishing them.

A smaller amount of binding has been done this session, 182 volumes having been bound in 139.

A record of the accessions to the library shows that, from April, 1906, to March, 1907, 688 serials and 61 separate works were received, a total of 749 volumes. The donations during the session (exclusive of the usual exchanges) amount to 59 volumes and 127 dissertations; 2 volumes have been purchased (in addition to the periodicals on the regular subscription list).

During the past session the Society has arranged to exchange publications with the following:—The Natal Government Museum, Pietermaritzburg; Sociedade Scientifica de São Paulo; Société d'Agriculture, Sciences et Industrie de Lyon; Albany Museum, Grahamstown; and the Museo Nacional de San Salvador.

The *Annual Reports of the Progress of Chemistry*, published by the Chemical Society, and *Science Progress*, have been added to the list of periodicals subscribed for.

The publication of the *Memoirs and Proceedings* has been continued under the supervision of the Editorial Committee.

Your Council is sorry to report that, owing to the increasing pressure of other duties, the Senior Honorary Secretary, and the Honorary Librarian, have intimated their desire not to be re-nominated for their respective offices at the ensuing election of the new Council.

Mr. Francis Jones has served the Society as one of its Secretaries since 1896, during which period his whole-hearted zeal, tact, and efficiency in furthering the interests of the Society are beyond adequate acknowledgment. The orderly way in which Mr. Jones has prepared the business for the Council, his judgment and skill in editing the *Memoirs and Proceedings* of the Society, his careful attention to the exacting correspondence

respecting its affairs, have evoked the admiration and the heartiest thanks of his colleagues.

Not less distinguished have been the services of Dr. William E. Hoyle, as librarian, extending over the long term of twelve years. During this period the whole of the Society's large library was completely rearranged on the Dewey system; the card-system of cataloguing the titles, authors, &c., of the books has been completed; the shelving and binding have been advanced as far as funds have been available; a constant look-out has been kept for *desiderata* to fill up gaps in the library; while the exchange of publications with other societies has been regularly maintained and extended. Little of the detailed desultory work of this nature comes directly under the eyes of the members; but the Council has expressed its high appreciation of the value of Dr. Hoyle's services as its librarian, and for his devotion in all the affairs of the Society.

Both these gentlemen have been constantly at their posts throughout the periods of their service, and your Council recommends their election as vice-presidents at the ensuing annual meeting.

The Society is indebted to the following gentlemen for the undermentioned gifts:—

Mr. Francis Nicholson, F.Z.S., for a volume of Scientific Memoirs which had been successively in the possession of Dr. Dalton, Eaton Hodgkinson, and Sir William Fairbairn, Bart.

Sir W. H. Bailey, for a framed enlarged photograph of the Statues of Dr. Dalton and Dr. Joule in the entrance hall of the Manchester Town Hall.

The late Sir Michael Foster, K.C.B., for a portrait of himself.

Dr. H. Wilde, F.R.S., for a copy of Mendeléeff's "Chemical Conception of the Ether."

The Council arranged for the Wilde Lecture to be delivered on Monday, February 18th, 1907, by Dr. J. A. Ewing, F.R.S., M.Inst.C.E., Director of Naval Education to the Admiralty. The subject of the Lecture was "The Structure of Metals."

The Council resolved that the following congratulatory letter be sent to the Royal Geographical Society of Australasia on the occasion of the celebration of the 21st anniversary of its foundation:—

"The Council of the Manchester Literary and Philosophi-
"cal Society desires to congratulate the Royal Geographical
"Society of Australasia on the occasion of the celebration of
"the Twenty-first Anniversary of its Foundation, and wishes
"to express the hope that the Society, which has done so
"much to advance the progress of natural science in the past,
"may long continue to carry on its useful work.

"(Signed) W. H. BAILEY, *President.*
FRANCIS JONES, } *Hon. Secretaries.*
F. W. GAMBLE, }

"*May 30th, 1906.*"

In MARCELLIN BERTHELOT the world has lost perhaps one of the most versatile, certainly one of the most strenuous of her men of genius.

Born in Paris in 1827 Berthelot began his professional career as laboratory assistant to Professor Ballard at the Collège de France. His first paper, published in 1850, was on the liquefaction of carbonic acid gas, but he soon turned to organic chemistry and described the action of heat on alcohol and on acetic acid. A chair of organic chemistry being created for him at the College, he worked first on oil of turpentine and then on glycerine and its compounds. His first organic syntheses were those of animal fats (1854), ethyl alcohol from ethylene (1855), formic acid from carbonic oxide (1855), and of methyl alcohol (1857). Then followed the important synthesis of acetylene direct from carbon and hydrogen (1862), and by heating acetylene he prepared benzene (1866). In the same year he synthesised marsh gas. Berthelot was the first to show that at a high temperature several molecules of a hydrocarbon may unite to form a new molecule—sometimes with the elimination of hydrogen: in this way he prepared diphenyl from benzene and anthracene from toluene.

In 1861 Berthelot published, with Péan de Saint Gilles, the first of his researches on affinity. He showed that the rate of formation of an ester depended upon the molecular quantities of the alcohol and acid present, thus affording an experimental proof of the law of mass action enunciated by Berthollet. As a corollary to this work, Berthelot naturally attacked the conclusions of Bunsen concerning the step-like nature of explosions in gases and of the incomplete combustion of carbonic oxide and hydrogen. Berthelot's own work on explosions culminated in 1881 in his discovery of the explosion-wave (l'onde explosive) in gases, and his theory of its propagation through explosive mixtures. This work was followed by a long investigation, in conjunction with Vieille, on the pressures produced in gaseous explosions from which the temperatures and specific heats of the products of combustion were deduced.

Perhaps Berthelot's most important researches have been his determinations of the heat changes accompanying chemical reactions, both those of formation and of decomposition. These researches led him to enunciate the principle that every chemical transformation, completed without the aid of external energy, tends to produce that substance or substances in the formation of which the maximum evolution of heat occurs.

We can only mention a few of the immense number of problems attacked by Berthelot, *e.g.*, the effect of the electric "effluve" on gases (in which he discovered persulphuric acid); the question of the fixation of nitrogen by plants which he carried out in his 'Laboratoire de chemie végétale' at Meudon near Paris; the reactions of acetylene and of cyanogen. All chemists too are indebted to Berthelot for his fascinating volumes on the Greek Alchemists and the origins of Alchemy.

Berthelot had many honours, but perhaps the award of the Jœcker prize to him by the Academy of Sciences in 1861 most affected his life and work. In that year he made his romantic marriage with Mlle. Bréquet—a union of the happiest kind,—only to end in the greater romance of their united death.

Berthelot was a rapid worker, and what he did he gave at once to the world. Hence the immense number of his published papers, and the occasional self-contradiction of the investigator. He seldom, if ever, left Paris except to go to his Vegetable Laboratory at Meudon, but he found time to serve on many Scientific Commissions and to give most valuable services to the Government and the Municipality. All work of an 'expert' kind for manufacturers and patentees he resolutely refused. How he acted as foreign minister forms part of the political history of our time.

Berthelot was a wonderfully effective lecturer: for not only did he marshal his facts with precision, but his arguments were lucid, and his sentences fell with a slow musical cadence delightful to listen to. His old students are unanimous in their appreciation of the affectionate regard he ever held them in;

those who crossed swords with him in scientific controversy found him a strenuous but always courteous opponent.

Berthelot was elected an honorary member of this Society in 1886. H. B. D.

LUDWIG BOLTZMANN was born at Vienna in 1844. He studied at the University there under Stefan, and afterwards for short periods at Heidelberg and Berlin, under Helmholtz and Kirchhoff. He was called in succession to professorships of mathematics or of theoretical physics at Graz (twice), Vienna (twice), Munich, and Leipzig. He died on September 3rd, 1906. He had long been recognised as one of the leading mathematical physicists of his time; he was a foreign member of the Royal Society, and had been an Honorary Member of our own Society since 1892.

Boltzmann's work bore mainly on the dynamical theory of gases, and on electromagnetic theory. Although the inspiration, always generously acknowledged, was in both cases derived from Maxwell, the subsequent development was thoroughly independent, and highly original. One result to which he was led in the theory of gases, and which now goes by the name of "Boltzmann's Theorem," excited the keenest interest and admiration in Maxwell himself. Owing to the subtlety of the reasoning on which it is based, and to its apparent inconsistency with known numerical properties of various gases, it has been the subject of a prolonged controversy, which is even yet, perhaps, hardly completely determined. His earliest achievements in the field of electricity were the experimental determination of the dielectric capacities of various gases, and of crystalline sulphur in various directions. Both investigations were interesting and important as verifying the theoretical views of Maxwell. At a later period he was occupied with the law of radiation.

Besides his scientific papers, Boltzmann published several treatises. One of these was a course of lectures on Maxwell's theory of electricity, designed to render the leading ideas of that

theory more accessible to German students. Boltzmann had indeed a large share in bringing about that closer approximation between English and German schools of physics which has been so marked in the last thirty years. He also wrote an elaborate treatise on the mathematical theory of gases, in which he sets forth his mature views on the subject. This theory is largely dependent on theoretical dynamics, and he was accordingly led to write a separate treatise on the latter subject. He was always fond of describing himself as "atomistic," and in this book he takes up a position of avowed antagonism to the wider, and consequently vaguer, conception of Mechanics which is formulated in the well-known treatise of Hertz.

An appreciative notice by the hand of a personal friend (Prof. G. H. Bryan) appeared in *Nature*, October 4th, 1906. We may also refer to the memoir by des Coudres, in the *Ber. k. Sachs. Gesell. d. Wissensch zu Leipzig*, vol. 58, p. 617, 1906. H. L.

Sir Michael Foster.—When the history of scientific thought and learning in this country is written, it will be found that the decade 1870-1880 was marked by changes in method and conception of Biology which, it is not an exaggeration to say, were revolutionary in character. The leadership of this revolution is by common consent assigned to Huxley, but the greatest and most successful of his generals was undoubtedly Michael Foster.

His campaign in Cambridge which led to the establishment and development of the great schools of Physiology, Pathology, Zoology, and Botany, of which the University is so justly proud, was not the only part of his life's work that exhibited his extraordinary powers of organisation, diplomacy, and appreciation of the true paths of scientific progress. But it was in Cambridge, rather than in any other sphere of his activities that his influence as a leader of a new movement was particularly powerful.

He was born at Huntingdon in 1836, and was the eldest son of a surgeon practising in that city. The last three

years of his school life were spent at University College School, London, where he was a contemporary of Joseph and Richard Chamberlain, W. Clowes, the publisher, Lord Romilly, J. W. Mellor, and other distinguished sons of nonconformist parents.

After a distinguished career at University College, London, first as a student of classics and afterwards of medicine, he joined his father in practice at Huntingdon, where he married his first wife. His wife died in 1869, leaving him a widower with one son and one daughter. In 1872 he married Miss Rust who survives him. After being in practice seven years, he returned to University College, London, and was appointed Teacher of Practical Physiology and subsequently Professor of Physiology. In 1870, Trinity College, Cambridge, founded a Praelectorship of Physiology, and, on the recommendation of Huxley, whom he had been assisting as a demonstrator in the first course of Elementary Biology, Foster was appointed to the new post.

From the date of Foster's appointment as Praelector in Physiology at Cambridge, the new schools of the Biological sciences in Cambridge began to grow and develop. In Newall Martin, Francis Balfour, Sidney Vines, and others who were among his first pupils, he found distinguished lieutenants to whom he could delegate the care of the several branches of Biology, while he himself remained the chief but unofficial director of their studies. In order that the study of these subjects, however, should be duly recognised, it was necessary that certain changes should be made in the somewhat antiquated arrangements of the Tripos examinations. The changes were made; but Foster himself could only look on and stimulate others in the good work of reform; for although he was made an honorary M.A. of the University, it was not until the lapse of thirteen years, when the Professorship of Physiology was founded, that he obtained the privileges of a voice and a vote in the councils of the University.

It is difficult to express in words the cause of his great influence in the University. The original investigations he had published, although important and stimulating, were not vast or monumental, and being on points of somewhat technical Physiological interest, did not attract the attention of the general world of learning. His lectures were delivered in a solemn monotone, and were devoid of the artificial stimulus to interest obtained by skilful table experiments or even coloured diagrams, and excepting during the first few years of his life in Cambridge, he seldom came to demonstrate himself in the laboratory. But the secret of his success seemed to be that he taught his pupils not only what we know, but also what we want to know, and every lecture seemed to give an impulse to all his pupils who possessed a grain of scientific feeling to go into the laboratory and try to find out something for themselves.

In his private room, after lecture, when he sat in his chair and puffed volumes of smoke from his pipe, Foster was at his best. It was then that he granted private interviews to his pupils, and few indeed there were who came out from that room without feeling the better for his words of wisdom and kindly interest.

Apart from his important work in Cambridge, Foster took an active interest in the proceedings of the Royal Society, of which he was Secretary for twenty two years, and of the British Association, of which he became President at the Dover meeting in 1899.

In 1900 Michael Foster was elected Member of Parliament for his old (London) University, and for a time sat on the Conservative side of the House as a Liberal Unionist, but being dissatisfied with some parts of the policy of the Government, particularly the Education Bill, he joined the opposition until the fall of the Balfour Ministry. In the General Election of 1906 he was defeated by Sir Philip Magnus by only 24 votes.

Foster, elected an honorary member of this Society in 1889, seldom visited us in Manchester, but many will

remember with interest the brilliant lecture he gave as Wilde lecturer of this Society in 1898, on "The Physical Basis of Psychical Events." He died in London on January 28th of this year, a few hours after he had delivered a short but valuable speech at a meeting of the British Science Guild. S. J. H.

By the death of DMITRI IWANOWITSCH MENDELÉEFF the Society has lost one of its most distinguished honorary members. The enunciator of the periodic classification of the elements, the author of the most original chemical text-book of modern times, a physical chemist of great experimental powers, an inspiring teacher and daring theorist, Mendeljeeff stood easily in the front rank of European chemists.

He was a Siberian, born at Tobolsk in 1834, and spent the whole of his life, with the brief exception of two years at Heidelberg, in Russia. His remarkable force of character, no less than his intellectual abilities, marked him out for rapid promotion, and in 1866 we find him professor of chemistry in the University of St. Petersburg. From that time until his death Mendeléeff was almost the dictator of Russian natural science. To him two generations of Russian chemists owe their training, and the confidence reposed in him by the Government was shown by his appointment to the sole control of the Standards Bureau.

His name is inseparably linked with the periodic law and classification of the elements. Though the previous work of Döbereiner, Dumas, Newlands and others had clearly hinted at the existence of a law correlating the properties of the elements with their atomic weights, it was left for Mendeléeff to make this clear—in his own words—"by raising the whole question to such a height that its reflection on all the facts could be clearly seen."

The year 1869 saw the enunciation of the periodic law by Mendeléeff, its illustration in his periodic system, and his bold challenge to the future by predicting in detail the properties of

elements then unknown. Within twenty years the discovery of gallium, germanium, and scandium gave the most striking confirmation to his prophecies—a confirmation which assisted materially in winning for his periodic system that assured place in chemical theory it now holds. Later work has done little to alter it; much to confirm its essential principle.

At times Mendeléeff's genius in evolving theories was only equalled by his ingenuity in defending them against experimental attack. His persistent devotion to the Mendeléeff-Gerhardt Law—that gases combine only in equal volumes—is a striking example of this.

His boldness and originality are still further shown in his "Principles of Chemistry"—a chemical text-book in no ordinary sense of the words, but a detailed exposition of the facts on which the periodic system is based. It abounds, too, in ideas stimulative of research.

His numerous papers on the properties of solutions give abundant evidence of Mendeléeff's experimental ability; and it is interesting to note that it was his study of the densities of mixtures of alcohol and water—work done for the Russian Government for excise purposes—which led him to regard solutions as "strictly definite, atomic, chemical combinations at temperatures higher than their dissociation temperatures."

Even this short account of Mendeléeff's life would be incomplete without some reference to his influence on the Russian petroleum industry. He made many journeys to the Caucasus and investigated at length the distribution and capacity of the Baku oil wells. His theory of the origin of petroleum is characteristic of the man. Petroleum, he declares, is continually being formed by the interaction of steam and metallic carbides below the surface of the earth, and the supply would therefore seem to be endless. Whatever may be thought of so bold a theory, there can be no doubt that the Baku petroleum industry owes its present position to Mendeléeff.

As a theorist he will be remembered, not only for his contri-

butions to chemical theory, but also for his daring attempts to show the oneness of things, to demonstrate that stellar and molecular mechanics are essentially the same. Perhaps the most noteworthy of these was a lecture delivered at the Royal Institution in 1889. Assuming the attractions between the atoms of a molecule to be gravitational, he showed that Newton's Third Law is adequate to explain all the facts of chemical substitution. His last speculation was the inclusion of the ether in his periodic system as an extremely light gas.

Mendeléeff was elected an honorary member of this Society in 1889. E. C. E.

HENRI MOISSAN was born in Paris on September 28th, 1852, and at an early age developed an interest in chemistry. In 1872 he entered the laboratory of Fremy at the *Muséum d'Histoire naturelle*, attending also the courses of Henri Sainte-Claire-Deville, Debray and others.

From 1873 to 1879 Moissan held the post of assistant in the Laboratory of MM. Decaisne and Dehérain at the *Muséum d'Histoire naturelle*, and in 1874 published, in conjunction with M. Dehérain, his first contribution to science, a study of the absorption of oxygen and emission of carbonic acid by plants kept in a darkened room. In 1877 a series of papers on the oxides of the metals of the iron group was commenced, the whole work being collected and presented in 1880 as a thesis for the degree of *Docteur ès sciences* of the Faculty of Sciences of the Paris University. This research carried out with much experimental skill and precision, considerably extended our knowledge of the reduction products of the oxides of iron, manganese, nickel, and chromium.

A long connection with the *École supérieure de Pharmacie* commenced in 1879, by his appointment as demonstrator in chemistry; the chair of toxicology being given him in 1887, after his memorable isolation of fluorine, and finally the professorship of *chimie minérale* in 1899, when his first opportunity occurred for holding a course of lectures on chemistry.

After his graduation, Moissan from 1879 to 1883, devoted himself at first chiefly to the study of the compounds of chromium, investigating in particular the chromous salts and perchromic acid. Subsequently, in the laboratory of Debray, and with the active encouragement of Troost and Friedel, he commenced his researches upon fluorine which culminated in 1886 in the isolation of this element.

The difficulties, which had baffled the experimental ability of Humphrey Davy, Faraday, Fremy, and many others, were overcome, and fluorine itself was presented to us. That this may justly be considered to be one of the greatest achievements of experimental chemistry in the nineteenth century can be judged not so much by the brilliant result attained as by the display of indomitable pluck and perseverance which assured the successful issue.

After a number of fruitless but well-planned attempts to separate the element from its compounds with silicon, phosphorus, and arsenic, Moissan, on June 28th, 1886, communicated to the Academy of Sciences, the first details of his experiments on the electrolysis of anhydrous hydrofluoric acid containing potassium bifluoride. The definite proofs of the identity and elementary nature of fluorine were presented in the following month, whilst, on November 8th, Debray reported to the academy the complete conviction of the section of chemistry of the validity of the experiments.

From 1886 to 1891, Moissan published numerous papers on the chemical and physical properties of fluorine and on many of its compounds, the careful and detailed nature of the investigation being characteristic of all his work.

Attention should also be directed to the fact that in 1897, in conjunction with Sir James Dewar, fluorine was liquefied at the Royal Institution. The construction of an apparatus of copper in 1899, to replace the expensive platinum vessels previously employed, simplified the preparation of the element, and the discovery that dry fluorine free from vapours of hydrofluoric

acid does not attack glass, served in recent years to facilitate the investigation of its properties.

In 1891 Moissan was elected a member of the Academy of Sciences to fill the chair left vacant by the death of Cahours.

The main reason which impelled him to pass from the study of fluorine to the high-temperature researches, which from 1892 onwards absorbed so much of his attention, seems to be closely connected with a desire, which he had long entertained, to solve the mystery of the origin of the diamond. The hope that the great activity of fluorine for other elements would help in the quest not being realised, he was led to a methodical study of the behaviour and transformation of the three allotropic modifications of carbon. This study, which is an excellent example of the logical application of experiment, resulted in the artificial production of diamond, and at the same time added greatly to our knowledge of the peculiar metamorphoses which characterise this element.

In electric furnace work Moissan's pre-eminent position is due, not to the design or discovery of a special form of furnace, but rather to the skill with which he investigated in detail a number of individual chemical reactions. In each case he devoted great care to the purification and analysis of the raw materials required in the process, and submitted the products to minute examination and quantitatively determined their composition. Thus his preparation of chromium, tungsten, molybdenum, uranium, titanium, and many other metals in a fused form and high degree of purity greatly enriched our knowledge of the chemical and physical properties of these elements.

Of still greater importance was the methodical following up of the chance formation of calcium carbide which he observed around the carbon electrodes in his early furnace experiments. From this observation he was led to discover and determine fully the nature and properties of a large number of metallic carbides, borides, and silicides, most of them hitherto

absolutely unknown, or, like the metals mentioned already, only obtainable as impure and fragmentary specimens.

There is perhaps no need to consider, at the present time, in how far industry is directly indebted to Moissan's work. He himself had invariably expressed his desire not to be considered in such discussions, and, so far as the merit of his work is concerned, it needs no support of this nature. Indirectly both science and industry have benefited enormously. On the Continent his scientific investigations are directly credited with a renaissance in the study of inorganic chemistry, which, particularly in Germany, had been almost entirely neglected for the more productive field of organic chemical research. Even in England, which has always held a high position in the pursuit of inorganic chemistry, his work has been of great assistance in instilling enthusiasm and encouraging the deeper study of the subject.

As a teacher, Moissan will be affectionately remembered by all his pupils; even during the tenure of his professorship of toxicology he maintained a research laboratory for chemistry, and attracted to it a number of students, and from the time of his appointment, in 1900, to the chair of inorganic chemistry at the Sorbonne larger numbers were able to avail themselves of his teaching.

Henri Moissan was elected an honorary member of this Society on April 26th, 1892, and on more than one occasion he had expressed his appreciation of this early recognition of his work. By his death at the early age of 55, Science has lost one of her most indefatigable workers.

The publication of a translation, with additions, of his experimental researches with the electric furnace* and articles in "Nature" vol. 37, p. 179, vol. 44, p. 622, vol. 65, p. 252, render much of his work readily available to the English reading public.

R. S. H.

* "The Electric Furnace" by H. Moissan, Transl. by A. T. de Mouilpied, London 1904, Edward Arnold.

By the death of Professor MARSHALL WARD in August last, botanical science has lost one of its ablest exponents. Born in 1854 at Hereford, he distinguished himself while studying at the Royal College of Science under Sir William Thiselton-Dyer, both by his great ability and his keen enthusiasm. After further studies both at the University of Cambridge and at Würzburg, under the late Professor Sachs, he was appointed by the Government of Ceylon, in 1880, to investigate the coffee-leaf disease in that island. He accomplished his task with considerable success and on his return in 1882, was elected Berkeley Fellow in the Owens College and subsequently became assistant to the late Professor Williamson. While in Manchester he published a number of botanical papers, some of which appear in Vol. 1 of the Owens College Biological Studies. They indicate that already at that time Ward's attention was strongly drawn to the group of fungi in which field of research he became one of the most prominent workers. Throughout his original investigations he displayed an originality and fertility of ideas and an indomitable perseverance which have rarely been equalled. The expositions of his investigations are characterised by a lucidity which carries conviction with it, and the results he obtained will be of lasting interest and importance.

Marshall Ward left Manchester to take up the post of Professor of Botany at the Royal Indian Engineering College at Cooper's Hill, where for ten years he prepared his pupils on Indian Woods and Forest Service. In 1895 he succeeded the late Professor Babington in the chair of Botany at the Cambridge University, which post he occupied with signal success until his death, two years after the opening of the new botanical institute at the University. This was the outward and visible manifestation of the great work he had done in raising the School of Botany at Cambridge to the foremost in the Kingdom.

But while Marshall Ward was always successful and inspiring as a teacher his unremitting work in botanical research raised

him to a foremost position among botanists and brought him acknowledgment from all learned Societies and Universities.

He was elected Fellow of the Royal Society in 1888 and received a Royal Medal in 1893, and in 1902 he received the degree of D.Sc. *honoris causa* from the University of Manchester and was elected honorary member of the Manchester Literary and Philosophical Society in 1894.

Those who knew him as a friend mourn in his death a genial companion, a man of varied interests but one who above all else was dominated by a whole-hearted devotion to his science. F. E. W.

CHARLES SNEATH ALLOTT was born at Lincoln, on May 17th, 1842, and there he received his early education. He was the son of the late Joseph Allott, maltster, of Lincoln and Newark-upon-Trent.

After being articled to Mr. L. H. Moorsom, M.Inst.C.E., he joined the Fairbairn Engineering Company in 1862, and remained with the firm till 1875, when he occupied the position of assistant manager. During this period he had charge of many important engineering works, including the roofs of the Albert Hall and of the Liverpool Street Station, London, the framework of the Spithead Ports and the Bridges of the Inter-Colonial Railway, Canada. In 1875 he commenced practice on his own account in Manchester, and was employed by different Railway Companies in the construction and repair of their iron bridges. He also designed large cotton mills for Brazil and China, and was responsible for the whole of the buildings of the new Electricity Generating Station of the Manchester Corporation in Stuart Street.

Mr. Allott was well known in masonic circles and was a past provincial officer of Freemasons and also of Royal Arch Masons in East Lancashire. At the time of his death he was Captain of the Manchester Golf Club, in the affairs of which he took the keenest interest for many years. Much of his time

was devoted to church and philanthropic work and he was a member of the committee of the Hospital Sunday Fund.

Mr. Allott was a member of the Institution of Civil Engineers, the Institution of Mechanical Engineers, also of the Liverpool Engineering Society and has been a member of this Society since 1902. He was a man of genial disposition and generous impulses and will be much missed by the large circle of his friends. His death took place with startling suddenness while in the Manchester Athenæum, on February 27th, 1907.

F. J.

NOTE.—The Treasurer's Accounts of the Session 1906-1907, of which the following pages are summaries, have been endorsed as follows:

April 15th, 1907. Audited and found correct.

We have also seen, at this date, the certificates of the following Stocks held in the name of the Society:—£1,225 Great Western Railway Company 5% Consolidated Preference Stock, Nos. 12,293, 12,294, and 12,323; £258 Twenty years' loan to the Manchester Corporation, redeemable 25th March, 1914 (No. 1564); £7,500 Gas Light and Coke Company Ordinary Stock (No. 6,389); and the deeds of the Natural History Fund, of the Wilde Endowment Fund, those conveying the land on which the Society's premises stand, and the Declaration of Trust.

Leases and Conveyance dated as follow:—

22nd Sept., 1797.
23rd Sept., 1797.
25th Dec., 1799.
" " "
22nd Dec., 1820.
23rd Dec., 1820.

Declarations of Trust:—

8th Jan., 1878.
24th June, 1801.
23rd Dec., 1820.
30th April, 1851.

We have also verified the balances of the various accounts with the bankers' pass books.

(Signed) { D. L. CHAPMAN.
C. L. BARNES.

MANCHESTER LITERARY AND

Dr. *Arthur McDougall, Treasurer, in Account with the*

			£ s. d.	£ s. d.
To Cash in hand, 1st April, 1906				142 10 1
To Members' Subscriptions:—				
Half Subscriptions,	1905-06,	1 at £1 11s. 6d.	1 1 0	
" "	1905-06,	5 " "	5 5 0	
" "	1906-07,	18½ " "	18 18 0	
Subscriptions:—	1903-04,	1 " £2 2s. 0d.	2 2 0	
"	1904-05,	4 " "	8 8 0	
"	1905-06,	12 " "	25 4 0	
"	1906-07,	108 " "	226 16 0	
"	1907-08,	1 " "	2 2 0	
				289 16 1
To Transfers from the Wilde Endowment Fund			. .	33 12 9
To Sale of Publications			. .	23 7 1
To Dividends:—				
Natural History Fund			58 3 8	
Joule Memorial Fund			7 7 2	
				65 10 10
To Income Tax Refunded:—				
Natural History Fund			3 1 3	
Joule Memorial Fund			0 7 6	
				3 8 11
				£610 5 1

NATURAL HISTORY

	£ s. d.
To Balance 1st April, 1906	1 16 9
To Dividends on £1,225 Great Western Railway Company's Stock	58 3 8
To Remission of Income Tax, 1906	3 1 1
	£ 1 1

JOULE MEMORIAL

	£ s. d.
To Balance, 1st April, 1906	72 11 4
To Dividends on £258 Loan to Manchester Corporation	7 7 2
To Remission of Income Tax, 1906	0 7 1
	£80 6 1

WILDE ENDOWMENT

	£ s. d.
To Balance 1st April, 1906	248 16 1
To Dividends on £7,500 Gas Light and Coke Company's Ordinary Stock	315 10 0
To Remission of Income Tax, 1906	16 10 0
To Bank Interest	3 10 3
To Discount on bills	0 19 1
	£585 5 5

DALTON TOM

	£ s. d.
To Balance, 1st April, 1906	35 4 1
To Bank Interest	0 17 6
	£36 1 1

PHILOSOPHICAL SOCIETY.

Society, from 1st April, 1906, to 31st March, 1907. **Cr.**

	£ s. d.	£. s. d.
By Charges on Property :—		
Chief Rent (Income Tax deducted)	12 5 4	
Income Tax on Chief Rent	0 12 11	
Insurance against Fire	13 17 6	
		26 15 9
By House Expenditure :—		
Coals, Gas, Electric Light, Water, &c.	43 1 4	
Tea, Coffee, &c., at Meetings	15 15 7½	
Cleaning, Sweeping Chimneys, &c.	6 9 2	
Crockery	0 4 0	
		65 10 1½
By Administrative Charges :—		
Housekeeper	63 8 0	
Postages, and Carriage of Parcels and of "Memoirs"	38 7 10	
Stationery, Cheques, Receipts, and Engrossing	6 8 11	
Printing Circulars, Reports, &c.	13 6 6	
Extra attendance at Meetings, and during housekeeper's holidays	3 10 0	
Miscellaneous Expenses	4 14 7½	
		129 15 10½
By Publishing :—		
Printing "Memoirs and Proceedings"	166 14 10	
Illustrations for "Memoirs" (except Nat. Hist. papers)	6 6 10	
Binding "Memoirs"	2 4 6	
		175 6 2
By Library :—		
Books and Periodicals (except those charged to Natural History Fund)	42 0 10	
Periodicals formerly subscribed for by the Microscopical and Natural History Section	3 7 0	
		45 7 10
By Natural History Fund :—		
(Items shown in the Balance Sheet of this Fund below)		60 7 9
By Joule Memorial Fund :—		
(No Expenditure this Session)		0 0 0
By Balance at Williams Deacon's Bank, 1st April, 1907	97 2 2	
,, ,, in Treasurer's hands	10 0 0	
		107 2 2
		£610 5 8

FUND, 1906—1907. (Included in the General Account, above.)

	£ s. d.
By Natural History Books and Periodicals	48 5 9
By illustrations for papers on Nat. Hist. in "Memoirs"	12 2 0
,, Balance, 1st April, 1907	2 13 11
	£63 1 8

FUND, 1906—1907. (Included in the General Account, above.)

	£ s. d.
(No expenditure this Session).	
By Balance, 1st April, 1907	80 6 2
	£80 6 2

FUND, 1906—1907.

	£ s. d.
By Assistant Secretary's Salary, April, 1906, to March, 1907	135 0 0
By Maintenance of Society's Library :—	
Binding and Repairing Books	23 16 10
By Repairs and Improvements to Society's Premises	92 13 8
By Providing and Furnishing Ladies' Lavatory	139 8 8
By Extension and Improvement of Electric Lighting	10 9 0
By Renewal of Furnishings, etc.	6 14 1
By Honorarium to Wilde Lecturer, 1907	15 15 0
By Expenses incurred by Lecture	4 0 11
By Transfers to Society's Funds	83 12 0
By Cheque Book	0 2 6
By Balance at District Bank, 1st April, 1907	71 12 9
	£583 5 5

FUND, 1906-1907.

	£ s. d.
(No Expenditure this Session).	
By Balance at Manchester and Salford Savings Bank, 1st April, 1907	36 1 8
	£36 1 8

THE COUNCIL
AND MEMBERS
CF THE
MANCHESTER
LITERARY AND PHILOSOPHICAL SOCIETY.

(Corrected to July 15th, 1907.)

President.

H. B. DIXON, M.A., F.R.S., F.C.S.

Vice-Presidents.

SIR WILLIAM H. BAILEY, M.I.Mech.E.
HORACE LAMB, M.A., LL.D., D.Sc., F.R.S.
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W. E. HOYLE, M.A., D.Sc., F.R.S.E.

Secretaries.

F. W. GAMBLE, D.Sc., F.R.S.
R. L. TAYLOR, F.C.S., F.I.C.

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Other Members of the Council.

FRANCIS NICHOLSON, F.Z.S.
CHARLES BAILEY, M.Sc., F.L.S.
THOMAS THORP, F.R.A.S.
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ERNEST F. LANGE, F.C.S.
WILLIAM J. POPE, F.R.S., F.C.S.

Assistant Secretary and Librarian.

A. P. HUNT, B.A.

ORDINARY MEMBERS.

Date of Election.

1901, Dec. 10. Adamson, Harold. *Oaklands Cottage, Godley, near Manchester.*

1902, Mar. 18. Allen, J. Fenwick. 147, *Withington Road, Whalley Range, Manchester.*

1870, Dec. 13. Angell, John, F.C.S., F.I.C. 6, *Beaconsfield, Derby Road, Withington, Manchester.*

1896, Jan. 31. Armstrong, Frank. 88, *Deansgate, Manchester.*

1865, Nov. 14. Bailey, Charles, M.Sc., F.L.S. *Atherstone House, North Drive, St. Annes-on-the-Sea, Lancs.*

1888, Feb. 7. Bailey, Alderman Sir William H., M.I.Mech.E. *Sale Hall, Sale, Cheshire.*

1895, Jan. 8. Barnes, Charles L., M.A. 8, *Swinton Avenue, Chorlton-on-Medlock, Manchester.*

1903, Oct. 20. Barnes, Jonathan, F.G.S. *South Cliff House*, 301, *Great Clowes Street, Higher Broughton, Manchester.*

1895, Mar. 5. Behrens, Gustav. *Holly Royde, Withington, Manchester.*

1898, Nov. 29. Behrens, Walter L. 22, *Oxford Street, Manchester.*

1868, Dec. 15. Bickham, Spencer H., F.L.S. *Underdown, Ledbury.*

1901, Nov. 12. Bles, Abraham J. S. *Palm House, Higher Broughton, Manchester.*

1896, Oct. 6. Bowman, F.H., D.Sc., F.R.S.E. 4, *Albert Square, Manchester.*

1875, Nov. 16. Boyd, John. *Barton House*, 11, *Didsbury Park, Didsbury, Manchester.*

1889, Oct. 15. Bradley, Nathaniel, F.C.S. *Sunnyside, Whalley Range, Manchester.*

1861, April 2. Brogden, Henry, F.G.S., M.I.Mech.E. *Hale Lodge, Altrincham, Cheshire.*

1889, April 16. Brooks, Samuel Herbert. *Slade House, Levenshulme, Manchester.*

1860, Jan. 24. Brothers, Alfred. *Handforth, near Manchester.*

1886, April 6. Brown, Alfred, M.A., M.D. *Sandycroft, Higher Broughton, Manchester.*

1889, Jan. 8. Brownell, Thomas William, F.R.A.S. 64, *Upper Brook Street, Manchester.*

1889, Oct. 15. Budenberg, C. F., M.Sc., M.I.Mech.E. *Bowdon Lane, Marple, Cheshire.*

Date of Election.

1906, Feb. 27. Burton, Joseph, A.R.C.S., Dublin. *Tile Works, Clifton Junction, near Manchester.*

1894, Nov. 13. Burton, William, F.C.S. *The Hollies, Clifton Junction, near Manchester.*

1904, Oct. 18. Campion, George Goring, L.D.S. 264, *Oxford Street, Manchester.*

1907, Jan. 15. Carpenter, H. C. H., M.A., Ph.D., Professor of Metallurgy in the University of Manchester. 11, *Oak Road, Withington, Manchester.*

1899, Feb. 7. Chapman, D. L., M.A., Fellow and Tutor of Jesus College, Oxford.

1901, Nov. 26. Chevalier, Reginald C., M.A., Mathematical Master at the Manchester Grammar School. 103, *Clyde Road, West Didsbury, Manchester.*

1902, Nov. 4. Clerk, Dugald, M.Inst.C.E., F.C.S. 18, *Southampton Buildings, Chancery Lane, London, W.C.*

1901, Nov. 12. Coignou, Caroline, M.A., Science Mistress at the Manchester High School for Girls. 60, *Cecil Street, Greenheys, Manchester.*

1895, April 30. Collett, Edward Pyemont. 8, *St. John Street, Manchester.*

1884, Nov. 4. Corbett, Joseph. *Town Hall, Salford.*

1903, Oct. 20. Core, William Hamilton, M.Sc. *Groombridge House, Withington, Manchester.*

1906, Oct. 30. Coward, H. F., M.Sc., Assistant Lecturer in Chemistry in the University of Manchester. *Hulme Hall, Plymouth Grove, Manchester.*

1906, Nov. 27. Coward, Thomas Alfred, F.Z.S. *Brentwood, Bowdon, Cheshire.*

1895, Nov. 12. Crossley, W. J., M.I.Mech.E. *Openshaw, Manchester.*

1904, Jan. 5. Darbishire, Arthur D., M.A., B.Sc., Lecturer and Demonstrator of Zoology in the Royal College of Science, London. *Royal College of Science, London, S.W.*

1901, Nov. 26. Darbishire, Francis V., B.A., Ph.D., Demonstrator and Analyst at the South Eastern Agricultural College. *The College, Wye, Kent.*

1895, April 9. Dawkins, W. Boyd, M.A., D.Sc., F.R.S., Professor of Geology in the Victoria University of Manchester. *Fallowfield House, Fallowfield, Manchester.*

Date of Election.

1894. Mar. 6. Delépine, A. Sheridan, M.B., B.Sc., Professor of Pathology in the Victoria University of Manchester. *The University, Manchester.*

1887, Feb. 8. Dixon, Harold Baily, M.A., M.Sc., F.R.S., F.C.S., Professor of Chemistry in the Victoria University of Manchester. *The University, Manchester.*

1905, Jan. 10. Duffield, W. Geoffrey, B.A., B.Sc., Research Fellow in the University of Manchester. *The University, Manchester.*

1906, Jan. 30. Dunkerley, Stanley, D.Sc., Professor of Engineering in the University of Manchester. *The University, Manchester.*

1906, Oct. 30. Edgar, E. C., D.Sc., Assistant Lecturer and Demonstrator in Chemistry in the University of Manchester. *Dalton Hall, Victoria Park, Manchester.*

1902, May 13. Ellison, Robert William. *'Brookside,' Crofts Bank Road, Urmston, Manchester.*

1905, May 2. Fearon, Ernest, Chemist to the Salford Corporation Gas Works. 31, *Russell Road, Whalley Range, Manchester.*

1906, Nov. 13. Fisher, Kenneth, B.A. Oxon., Ph.D. Jena, Research Student in the University of Manchester. *The Lilacs, Timperley, Cheshire.*

1898, Nov. 29. Gamble, F. W., D.Sc., F.R.S., Assistant Director of the Zoological Laboratories of the Victoria University of Manchester. *The University, Manchester*, and 16 *Amherst Street, Withington.*

1896, Nov. 17. Gordon, Rev. Alexander, M.A. *Summerville, Victoria Park, Manchester.*

1905, Nov. 20. Grimshaw, William Edwin, B.A., Physics Master, Manchester Grammar School. 46, *Broadway Street, Oldham.*

1902, April 29. Herbert, Arthur M., B.A. *Frankwyn, Hale, Cheshire.*

1905, Oct. 17. Hewitt, Charles Gordon, B.Sc., Lecturer in Economic Zoology in the Victoria University of Manchester. *The University, Manchester.*

1902, Jan. 7. Hewitt, David B., M.D. *Grove Mount, Davenham, Cheshire.*

Date of Election.

1895, Mar. 5. Hickson, Sydney J., M.A., D.Sc., F.R.S., Professor of Zoology in the Victoria University of Manchester. *The University, Manchester.*

1884, Jan. 8. Hodgkinson, Alexander, M.B., B.Sc. 18, *St. John Street, Manchester.*

1906, Oct. 16. Holmes, H. T., M.A. (Cantab.). *Eastnor, 77, Wellington Road, Heaton Chapel.*

1905, Nov. 14. Holt, Alfred, M.A., Research Fellow of the University of Manchester. *Crofton, Aigburth, Liverpool.*

1896, Nov. 3. Hopkinson, Edward, M.A., D.Sc., M.Inst.C.E. *Ferns, Alderley Edge, Cheshire.*

1889, Oct. 15. Hoyle, William Evans, M.A., D.Sc., F.R.S.E., Director of the Manchester Museum. *The University, Manchester.*

1900, Oct. 16. Hutton, R. S., D.Sc., Lecturer on Electro-Chemistry in the Victoria University of Manchester. *The University, Manchester.*

1899, Oct. 17. Ingleby, Joseph, M.I.Mech.E. *Summer Hill, Pendleton, Manchester.*

1901, Nov. 26. Jackson, Frederick. 14, *Cross Street, Manchester.*

1870, Nov. 1. Johnson, William H., B.Sc. *Woodleigh, Altrincham.*

1878, Nov. 26. Jones, Francis, M.Sc., F.R.S.E., F.C.S. *Manchester Grammar School*, and *Beaufort House, Alexandra Park, Manchester.*

1886, Jan. 12. Kay, Thomas. *Moorfield, Stockport, Cheshire.*

1895, Nov. 12. Kirkman, William Wright. *The Grange, Timperley, Cheshire.*

1903, Feb. 3. Knecht, Edmund, Ph.D., Professor of Tinctorial Chemistry at the Municipal School of Technology, Manchester. *Beech Mount, Marple, Cheshire.*

1904, Oct. 18. Knowles, H. B., M.A., Principal of the Royal Technical Institute, Salford. *'Norcote,' Swinton Park, Salford.*

1902, Feb. 4. Kolp, Noah. *Woodthorpe, Victoria Park, Manchester.*

1893, Nov. 14. Lamb, Horace, M.A., LL.D., D.Sc., F.R.S., Professor of Mathematics in the Victoria University of Manchester. 6, *Wilbraham Road, Fallowfield, Manchester.*

Date of Election.

1902, Jan. 7. Lange, Ernest F, F.C.S. *Fairholme*, 3, *Willow Bank, Fallowfield, Manchester.*

1904, Mar. 15. Lea, Arnold W. W., M.D. 246, *Oxford Road, Manchester.*

1903, Nov. 17. Leigh, Charles W. E, Librarian of the University. *The University, Manchester.*

1902, Nov. 4. Leigh, Joseph Egerton. *The Towers, Didsbury, Manchester.*

1902, Jan. 7. Longridge, Michael, M.A., M.Inst.C.E. *Linkvretten, Ashley Road, Bowdon, Cheshire.*

1857, Jan. 27. Longridge, Robert Bewick, M.I.Mech.E. *Yew Tree House, Tabley, Knutsford, Cheshire.*

1866, Nov. 13. McDougall, Arthur, B.Sc. *Lyndhurst, The Park, Buxton.*

1905, Oct. 31. McNicol, Mary, B.Sc., Research Scholar in the Victoria University of Manchester. 182, *Upper Chorlton Road, Manchester.*

1904, Nov. 1. Makower, Walter, B.A., B.Sc. 214, *Upper Brook Street, Manchester.*

1902, Mar. 4. Mandleberg, Goodman Charles. *Redclyffe, Victoria Park, Manchester.*

1875, Jan. 26. Mann, J. Dixon, M.D., F.R.C.P. (Lond.), Professor of Medical Jurisprudence in the Victoria University of Manchester. 16, *St. John Street, Manchester.*

1901, Dec. 10. Massey, Herbert. *Ivy Lea, Burnage, Didsbury, Manchester.*

1864, Nov. 1. Mather, Sir William, M.Inst.C.E., M.I.Mech.E. *Iron Works, Salford.*

1873, Mar. 18. Melvill, James Cosmo, M.A., F.L.S. *Meole-Brace Hall, Shrewsbury.*

1881, Oct. 18. Mond, Ludwig, D.Sc., Ph.D., F.R.S., F.C.S. *Winnington Hall, Northwich, Cheshire.*

1894, Feb. 6. Mond, Robert Ludwig, M.A., F.R.S.E., F.C.S. *Winnington Hall, Northwich, Cheshire.*

1903, Oct. 20. Moore, Frederick Craven, M.D., M.Sc., 61, *Ardwick Green, Manchester.*

1899. Mar. 7. Morris, Edgar F., M.A., F.C.S. *Grey House, Barrington Road, Altrincham, Cheshire.*

1902, Feb. 18. Moss, William E., B.A. *C/o Messrs. Davies, Benachi & Co., 7, Rumford Street, Liverpool.*

1873, Mar. 4. Nicholson, Francis, F.Z.S. *The Knoll, Windermere, Westmorland.*

Date of Election.

1900, April 3. Nicolson, John T., D.Sc., Professor of Engineering at the Municipal School of Technology, Manchester. *Nant-y-Glyn, Marple, Cheshire.*

1889 April 16. Norbury, George. *Hillside, Prestwich Park, Prestwich, Lancs.*

1884, April 15. Okell, Samuel, F.R.A.S. *Overley, Langham Road, Bowdon, Cheshire.*

1903, Jan. 6. Oldham, Charles. *Brook Cottage, Knutsford, Cheshire.*

1901, Nov. 26. Paine, Standen. *Devisdale, Bowdon, Cheshire.*

1892, Nov. 15. Perkin, W. H., jun., Ph.D., M.Sc., F.R.S., Professor of Organic Chemistry in the Victoria University of Manchester. *The University, Manchester.*

1901, Oct. 29. Petavel, J. E., B.A., M.Sc., F.R.S., Lecturer on Mechanics in the Victoria University of Manchester. *The University, Manchester.*

1885, Nov. 17. Phillips, Henry Harcourt, F.C.S. *Lynwood, Turton, nr. Bolton, Lancs.*

1902, Oct. 21. Pope, W. J., F.R.S., F.C.S., Professor of Chemistry at the Municipal School of Technology, Manchester. *Corchester, Bramhall, Cheshire.*

1903, Dec. 15. Prentice, Bertram, Ph.D., D.Sc., Lecturer in Chemistry, Royal Technical Institute, Salford. *Isca Mount, Manchester Road, Swinton.*

1904, Feb. 2. Radford, Catherine, B.Sc. 31, *Cawdor Road, Fallowfield, Manchester.*

1900, Feb. 20. Ragdale, John R. *The Beeches, Whitefield, near Manchester.*

1901, Dec. 10. Ramsden, Herbert, M.D. (Lond.), M.B., Ch.B. (Vict.). *Sunnyside, Dobcross, near Oldham, Lancs.*

1888, Feb. 21. Rée, Alfred, Ph.D., F.C.S. 15, *Maulden Road, Withington, Manchester.*

1906, Oct. 30. Renold, Charles G., Engineer. 35, *Mabfield Road, Fallowfield, Manchester.*

1869, Nov. 16. Reynolds, Osborne, M.A., LL.D., F.R.S., M.Inst.C.E. 19, *Ladybarn Road, Fallowfield, Manchester.*

Date of Election.

1880, Mar. 23. Roberts, D. Lloyd, M.D., F.R.S.E., F.R.C.P. (Lond.). *Ravenswood, Broughton Park, Manchester.*

1897, Oct. 19. Rothwell, William Thomas. *Heath Brewery, Newton Heath, near Manchester.*

1905, Oct. 31. Saxelby, Edith Mary, B.Sc., Research Scholar in the Victoria University of Manchester. 3, *Alexandra Road South, Alexandra Park, Manchester.*

1873, Nov. 18. Schuster, Arthur, Sc.D., Ph.D., F.R.S., F.R.A.S., Honorary Professor of Physics in the Victoria University of Manchester. *Kent House, Victoria Park, Manchester.*

1898, Jan. 25. Schwabe, Louis. *Hart Hill, Eccles Old Road, Pendleton, Manchester.*

1890, Nov. 4. Sidebotham, Edward John, M.A., M.B., M.R.C.S. *Erlesdene, Bowdon, Cheshire.*

1903, April 28. Sidebottom, Henry. *The Hall Cottage, Cheadle Hulme, near Stockport.*

1906, Oct. 30. Smedley, Ida, D.Sc., Assistant Lecturer in Chemistry in the Victoria University of Manchester. *The University, Manchester.*

1906, Nov. 27. Smith, Norman, D.Sc., Assistant Lecturer in Chemistry in the Victoria University of Manchester. *The University, Manchester.*

1895, Nov. 12. Southern, Frank, B.Sc. 6, *Park Avenue, Timperley, Cheshire.*

1896, Feb. 18. Spence, David. *Honeyhanger, Haslemere, Surrey.*

1901, Dec. 10. Spence, Howard. *Audley, Broad Road, Sale, Cheshire.*

1904, Nov. 1. Stansfeld, Herbert, B.Sc., A.I.E.E. 20, *Every Street, Ancoats, Manchester.*

1905, May 2. Stopes, Marie C., D.Sc., Ph.D., Demonstrator of Botany in the University of Manchester. 11, *Kensington Avenue, Victoria Park, Manchester.*

1897, Nov. 30. Stromeyer, C. E., M.Inst.C.E. *Steam Users' Association, 9, Mount Street, Albert Square, Manchester.*

1905, Nov. 1. Sutcliffe, William Henry, F.G.S. *Shore, Littleborough, Lancs.*

1895, April 9. Tatton, Reginald A., M.Inst.C.E. Engineer to the Mersey and Irwell Joint Committee. *Manor House, Chelford, Cheshire.*

Date of Election.

1893, Nov. 14. Taylor, R. L., F.C.S., F.I.C. *Central School, Whitworth Street*, and 4, *St. Werburgh's Road, Chorlton-c.-Hardy, Manchester.*

1906, April 10. Thewlis, Councillor J. H. *Daisy Mount, Victoria Park, Manchester.*

1873, April 15. Thomson, William, F.R.S.E., F.C.S., F.I.C. *Royal Institution, Manchester.*

1896, Jan. 21. Thorburn, William, M.D., B.Sc. 2, *St. Peter's Square, Manchester.*

1896, Jan. 21. Thorp, Thomas, F.R.A.S. *Moss Bank, Whitefield, near Manchester.*

1899, Oct. 31. Thorpe, Jocelyn F., Ph.D., Demonstrator in Organic Chemistry in the Victoria University of Manchester. *The University, Manchester.*

1899, Oct. 17. Todd, William Henry. *Greenfield, Flixton, near Manchester*, and *Sickle Street, corner of* 84, *Market Street.*

1873, Nov. 18. Waters, Arthur William, F.L.S., F.G.S. "*Alderley*," *McKinley Road, Bournemouth.*

1906, Nov. 13. Watson, D. M. S. 466, *Moss Lane East, Manchester.*

1892, Nov. 15. Weiss, F. Ernest, D.Sc., F.L.S., Professor of Botany in the Victoria University of Manchester. 30, *Brunswick Road, Withington, Manchester.*

1906, Oct. 30. Wigglesworth, Grace, M.Sc. *Sparth Mount, Heaton Norris.*

1901, Oct. 1. Wild, Robert B., M.D., M.Sc., M.R.C.P., Professor of Materia Medica and Therapeutics in the Victoria University of Manchester. *Broome House, Fallowfield Manchester.*

1859, Jan. 25. Wilde, Henry, D.Sc., D.C.L., F.R.S. *The Hurst, Alderley Edge, Cheshire.*

1905, Oct. 31. Willis, Ethel G., M.A., B.Sc., Science Mistress, Manchester High School for Girls. 2, *Lancaster Road, Fallowfield, Manchester.*

1901, Nov. 26. Wilson, William, M.A. *Carron Vale*, 80, *Fitzwarren Street, Pendleton, Manchester.*

1905, Oct. 31. Woodall, Herbert J., A.R.C.S. 32, *Market Place, Stockport.*

1860, April 17. Woolley, George Stephen. *Victoria Bridge, Manchester.*

Date of Election.

1903, Nov. 17. Worthington, John Henry William, B.A., Assistant Master at the Manchester Grammar School. 9, *Woodfield Road, Cheadle Hulme, near Stockport.*

1863, Nov. 17. Worthington, Samuel Barton, M.Inst.C.E., M.I.Mech.E. *Mill Bank, Bowdon,* and 37, *Princess Street, Manchester.*

1865, Feb. 21. Worthington, Thomas, F.R.I.B.A. *Broomfield, Alderley Edge, Manchester.*

1895, Jan. 8. Worthington, Wm. Barton, B.Sc., M.Inst.C.E. *Kirkstyles, Duffield, near Derby.*

1897, Oct. 19. Wyatt, Charles H., M.A., *Chelford, Cheshire.*

N.B.—Of the above list the following have compounded for their subscriptions, and are therefore life members:—

Bailey, Charles, M.Sc., F.L.S.
Bradley, Nathaniel, F.C.S.
Brogden, Henry, F.G.S.
Ingleby, Joseph, M.I.Mech.E.
Johnson, William H., B.Sc.
Worthington, Wm. Barton, B.Sc.

HONORARY MEMBERS.

Date of Election.

1892, April 26. Abney, Sir W. de W., K.C.B., D.Sc., F.R.S. *Rathmore Lodge, Bolton Gardens South, South Kensington, London, S.W.*

1892, April 26. Amagat, E. H., For. Mem. R.S., Memb. Inst. Fr. (Acad. Sci.), Examinateur à l'École Polytechnique. *Avenue d'Orléans*, 19, *Paris.*

1894, April 17. Appell, Paul, Membre de l'Institut, Professor of Theoretical Mechanics. *Faculté des Sciences, Paris.*

1892, April 26. Ascherson, Paul F. Aug., Professor of Botany. *Universität, Berlin.*

1889, April 30. Avebury, John Lubbock, Lord, D.C.L., LL.D., F.R.S. *High Elms, Down, Kent.*

1892, April 26. Baeyer, Adolf von, For. Mem. R.S., Professor of Chemistry. 1, *Arcisstrasse, Munich.*

1886, Feb. 9. Baker, John Gilbert, F.R.S., F.L.S. 3, *Cumberland Road, Kew.*

1888, April 17. Cannizzaro, Stanislao, For. Mem. R.S., Corr. Memb. Inst. Fr. (Acad. Sci.), Professor of Chemistry. *Reale Università, Rome.*

1889, April 30. Carruthers, William, F.R.S., F.L.S. 14, *Vermont Road, Norwood, London, S.E.*

1903, April 28. Clarke, Frank Wigglesworth, D.Sc. *United States Geological Survey, Washington, D.C., U.S.A.*

1866, Oct. 30. Clifton, Robert Bellamy, M.A., F.R.S., F.R.A.S., Professor of Natural Philosophy. 3, *Baraweil Road, Banbury Road, Oxford.*

1892, April 26. Curtius, Theodor, Professor of Chemistry. *Universitat, Kiel.*

1892, April 26. Darboux, Gaston, Membre de l'Institut, Professor of Geometry, Faculté des Sciences, Secrétaire perpétuel de l'Académie des Sciences. 36, *Rue Gay Lussac, Paris.*

1894, April 17. Debus, H., Ph.D., F.R.S. 4. *Schlangenweg, Cassel, Hessen, Germany.*

1888, April 17. Dewalque, Gustave, Professor of Geology. *Université, Liége.*

Date of Election.

1900, April 24. Dewar, Sir James, M.A., LL.D., D.Sc., F.R.S., V.P.C.S., Fullerian Professor of Chemistry. *Royal Institution, Albemarle Street, London, W.*

1892, April 26. Dohrn, Dr. Anton, For. Mem. R.S. *Zoologische Station, Naples.*

1892, April 26. Edison, Thomas Alva. *Orange, N.J., U.S.A.*

1895, April 30. Elster, Julius, Ph.D. 6, *Lessingstrasse, Wolfenbüttel.*

1900, April 24. Ewing, James Alfred, C.B., M.A., LL.D., F.R.S., Director of Naval Education to the Admiralty. *Royal Naval College, Greenwich.*

1889, April 30. Farlow, W. G., Professor of Botany. *Harvard College, Cambridge, Mass., U.S.A.*

1900, April 24. Forsyth, Andrew Russell, M.A., Sc.D., F.R.S., Sadlerian Professor of Pure Mathematics. *Trinity College, Cambridge.*

1892, April 26. Fürbringer, Max, Professor of Anatomy. *Universität, Heidelberg.*

1900, April 24. Geikie, James, D.C.L., LL.D., F.R.S., Murchison Professor of Geology and Mineralogy. *Kilmorle, Colinton Road, Edinburgh.*

1895, April 30. Geitel, Hans. 6, *Lessingstrasse, Wolfenbüttel.*

1894, April 17. Glaisher, J. W. L., Sc.D., F.R.S., Lecturer in Mathematics. *Trinity College, Cambridge.*

1894, April 17. Gouy, A., Corr. Memb. Inst. Fr. (Acad. Sci.), Professor of Physics. *Faculté des Sciences, Lyons.*

1900, April 24. Haeckel, Ernst, Ph.D., Professor of Zoology. *Zoologisches Institut, Jena.*

1894, April 17. Harcourt, A. G. Vernon, M.A., D.C.L., F.R.S., V.P.C.S. *St. Clare, Ryde, Isle of Wight.*

1894, April 17. Heaviside, Oliver, F.R.S. *Bradley View, Newton Abbot, Devon.*

1892, April 26. Hill, G. W. *West Nyack, N.Y., U.S.A.*

Date of Election.

1888, April 17. Hittorf, Johann Wilhelm, Professor of Physics. *Polytechnicum, Münster.*

1892, April 26. Hoff, J. van't, Ph.D., For. Mem. R.S., Professor of Chemistry. 2, *Uhlandstrasse, Charlottenburg, Berlin.*

1892, April 26. Hooker, Sir Joseph Dalton, G.C.S.I., C.B., D.C.L., F.R.S., Corr. Memb. Inst. Fr. (Acad. Sci.). *The Camp, Sunningdale, Berks.*

1869, Jan. 12. Huggins, Sir William, O.M., K.C.B., LL.D., D.C.L., F.R.S., F.R.A.S., Corr. Memb. Inst. Fr. (Acad. Sci.). 90, *Upper Tulse Hill, Brixton, London, S.W.*

1851, April 29. Kelvin, William Thomson, Lord, O.M., G.C.V.O., M.A., D.C.L., LL.D., F.R.S., F.R.S.E., For. Assoc. Inst. Fr. (Acad. Sci.). *Netherhall, Largs, Ayrshire.*

1892, April 26. Klein, Felix, Ph.D., For. Mem. R.S., Corr. Memb. Inst. Fr. (Acad. Sci.), Professor of Mathematics. 3, *Wilhelm Weber Strasse, Göttingen.*

1894, April 17. Königsberger, Leo, Professor of Mathematics. *Universität, Heidelberg.*

1892, April 26. Ladenburg, A., Ph.D., Professor of Chemistry. 3, *Kaiser Wilhelm Strasse, Breslau.*

1902, May 13. Larmor, Joseph, M.A., D.Sc., LL.D., Sec. R.S., F.R.A.S. *St. John's College, Cambridge.*

1892, April 26. Liebermann, C., Professor of Chemistry. 29, *Matthai-Kirch Strasse, Berlin.*

1887, April 19. Lockyer, Sir J. Norman, K.C.B., F.R.S., Corr. Memb. Inst. Fr. (Acad. Sci.). *Science School, South Kensington, London, S.W.*

1902, May 13. Lodge, Sir Oliver Joseph, D.Sc., LL.D., F.R.S., Principal of the University of Birmingham. *The University, Birmingham.*

1900, April 24. Lorentz, Henrik Anton, Corr. Memb. Inst. Fr. (Acad. Sci.), Professor of Physics. *Hooigracht, 48, Leyden.*

1892, April 26. Marshall, Alfred, M.A., Professor of Political Economy. *Balliol Croft, Madingley Road, Cambridge.*

1892, April 26. Mascart, E. E. N., For. Mem. R.S., Membre de l'Institut, Professor at the Collège de France. 16, *Rue Christophe Colomb, Paris, &c.*

Date of Election.

1901, April 23. Metschnikoff, Élie, D.Sc., For.Mem.R.S. *Institut Pasteur, Paris.*

1895, April 30. Mittag-Leffler, Gösta, D.C.L. (Oxon.), For. Mem. R.S., Professor of Mathematics. *Djursholm, Stockholm.*

1894, April 17. Murray, Sir John, K.C.B., LL.D., D.Sc., F.R.S. *Challenger Lodge, Wardie, Edinburgh.*

1894, April 17. Neumayer, Professor G., For. Mem. R.S., Director of the Seewarte. *Hohenzollern Strasse, 9, Neustadt an der Haardt, Germany.*

1887, April 19. Newcomb, Simon, For. Mem. R.S., For. Assoc. Inst. Fr. (Acad. Sci.), Professor of Mathematics and Astronomy. 1620, *P Street, Washington, D.C., U.S.A.*

1902, May 13. Osborn, Henry Fairfield, Professor of Vertebrate Palæontology. *Columbia College, New York, U.S.A.*

1894, April 17. Ostwald, W., Professor of Chemistry. *Groszbothen, Kgr. Sachsen.*

1899, April 25. Palgrave, R. H. Inglis, F.R.S., F.S.S. *Henstead Hall, Wrentham, Suffolk.*

1894, April 17. Pfeffer, Wilhelm, For. Mem. R.S., Professor of Botany. *Botanisches Institut, Leipsic.*

1892, April 26. Poincaré, H., For. Mem. R.S., Membre de l'Institut, Professor of Astronomy. 63, *Rue Claude Bernard, Paris.*

1892, April 26. Quincke, G. H., For. Mem. R.S., Professor of Physics. *Universität, Heiuelberg.*

1899, April 25. Ramsay, Sir William, K.C.B., Ph.D., F.R.S., Professor of Chemistry in University College, London. 12, *Arundel Gardens, Notting Hill, London, W.*

1886, Feb. 9. Rayleigh, John William Strutt, Lord, O.M., M.A., D.C.L. (Oxon.), LL.D. (Univ. McGill), P.R.S., F.R.A.S., Corr. Memb. Inst. Fr. (Acad. Sci.). *Terling Place, Witham, Essex.*

Date of Election.

1900, April 24. Ridgway, Robert, Curator of the Department of Birds, U.S. National Museum. *Brookland, District of Columbia, U.S.A.*

1897, April 27. Roscoe, Sir Henry Enfield, B.A., LL.D., D.C.L., F.R.S., V.P.C.S., Corr. Memb. Inst. Fr. (Acad. Sci.). 10, *Bramham Gardens, Earl's Court, London, S.W.*

1902, May 13. Scott, Dukinfield Henry, M.A., Ph.D, F.R.S., F.L.S. *East Oakley House, Oakley, Hants.*

1892, April 26. Sharpe, R. Bowdler, LL D., F.L.S., F.Z.S. *British Museum (Natural History), Cromwell Road, London, S.W.*

1892, April 26. Solms, H., Graf zu, Professor of Botany. *Universität, Strassburg.*

1869, Dec. 14. Sorby, Henry Clifton, LL.D., F.R.S., F.L.S., F.G.S. *Broomfield, Sheffield.*

1886, Feb. 9. Strasburger, Eduard, D.C.L., For. Mem. R.S., Professor of Botany. *Universität, Bonn.*

1895, April 30. Suess, Eduard, Ph.D., For. Mem. R.S., For. Assoc. Inst. Fr. (Acad. Sci.), Professor of Geology. 9, *Africanergasse, Vienna.*

1892, April 26. Thiselton-Dyer, Sir W. T., K.C.M.G., C.I.E., M.A., Sc.D., Ph.D., LL.D., F.R.S. Lately Director Royal Botanic Gardens, Kew. *The Ferns, Witcombe, Gloucester.*

1895, April 30. Thomson, Joseph John, M.A., Sc.D., F.R.S., Professor of Experimental Physics. 6, *Scrope Terrace, Cambridge.*

1894, April 17. Thorpe, T. E., C.B., Ph.D., D.Sc., LL.D., F.R.S., V.P.C.S. *Government Laboratory, Clement's Inn Passage, Strand, London, W.C.*

1894, April 17. Turner, Sir William, K.C.B., M.B., D.C.L., F.R.S., F.R.S.E, Professor of Anatomy. 6, *Eton Terrace, Edinburgh.*

1886, Feb. 9. Tylor, Edward Burnett, D.C.L. (Oxon), LL.D. (St. And. and McGill Univs.), F.R.S., Professor of Anthropology. *Museum House, Oxford.*

1894, April 17. Vines, Sidney Howard, M.A., D.Sc., F.R.S., Sherardian Professor of Botany. *Headington Hill, Oxford.*

Date of Election.

1894, April 17. Warburg, Emil, Professor of Physics. *Physikalisches Institut, Neue Wilhelmstrasse, Berlin.*

1894, April 17. Weismann, August, Professor of Zoology. *Universität, Freiburg i. Br.*

1886, Feb. 9. Young, Charles Augustus. *Hanover, New Hampshire, U.S.A.*

1888, April 17. Zirkel, Ferdinand, For. Mem. R.S., Professor of Mineralogy. *Thralstrasse, 33, Leipsic.*

CORRESPONDING MEMBER.

1850, April 30 Harley, Rev. Robert, Hon. M.A. (Oxon), F.R.S., F.R.A.S., Hon. Memb. R.S. Queensland. *Rosslyn, Westbourne Road, Forest Hill, London, S.E.*, and *The Athenæum Club, London, S.W.*

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